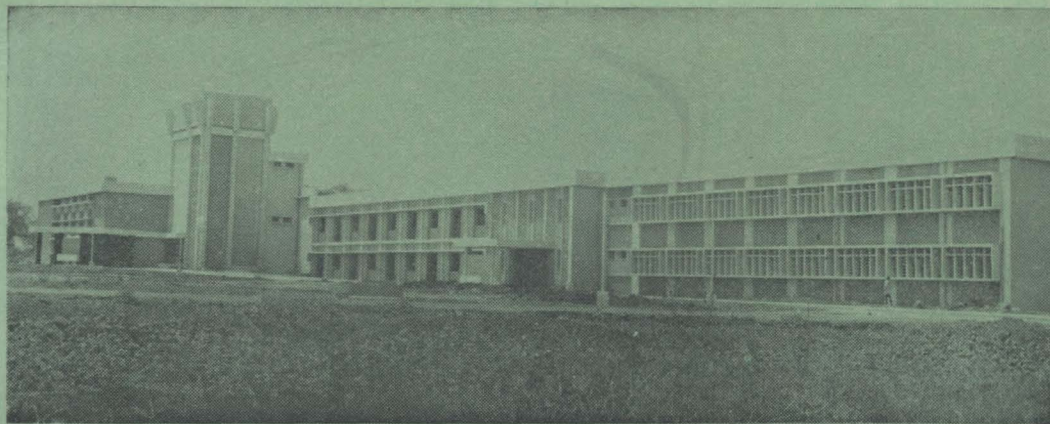




IGAR

**ANNUAL
REPORT
1971**



**INDIAN GRASSLAND AND FODDER
RESEARCH INSTITUTE**

JHANSI

Indian Council of Agricultural Research

annual report
1971

**INDIAN GRASSLAND AND FODDER
RESEARCH INSTITUTE
J H A N S I**

CONTENTS

| | Page |
|---|------|
| Introduction | 1 |
| Objectives | 1 |
| Organization | 2 |
| Staff Pattern | 3 |
| Facilities | 7 |
| (a) Experimental Farm | |
| (b) Laboratories | |
| (c) Library | |
| (d) Museum | |
| (e) Advanced Training to Staff | |
| Research Collaboration at National Level | 9 |
| Research Collaboration at International Level | 9 |
| Extension and Education | 9 |
| (a) Advisory Services | |
| (b) Technical Publication and Talks | |
| (c) Seed Supply | |
| (d) National Demonstration | |
| (e) Training | |
| Workshops/Conferences/Symposia | 10 |
| Finance | 11 |
| Visitors | 11 |
| Visits Abroad | 14 |
| Honours and Awards | 14 |
| Weather Condition and Crop Prospects | 14 |

Progress of Research

| | |
|---|----|
| Technical Programme of 1971 | 16 |
| Plant Improvement Division | 20 |
| Soil Science and Agronomy Division | 36 |
| Grassland Management Division | 47 |
| Weed Ecology and Control Division | 54 |
| Plant Animal Relationship Division | 60 |
| Agricultural Engineering Section | 65 |
| Agricultural Economics and Statistics Section | 66 |
| Cartography Section | 69 |
| Farm Section | 70 |
| Publications | 71 |
| Summary | 75 |

INTRODUCTION

The green revolution has brought us self-sufficiency in food production. Inclusion of protein-rich food like milk, milk products and meat, for a balanced diet needs equal emphasis. This is well within our reach provided adequate quantities of nutritious grasses and fodders are made available to our large livestock population through improved production techniques and efficient utilization.

To meet, in fact, the appropriate food and fodder requirement of the bovine population in India, the production of concentrates, green fodder and dry fodder will have to be increased by 6, 1.73 and 2.7 times the present production. The production may have to be further increased, keeping in view the increase of 1.96 per cent per year in the cattle population in our country. Thus, the all-round development of fodder and feed resources of the country, therefore, becomes at once, a high priority national problem. Again, fodder production is of special importance in rainfed areas where farm power continues to depend heavily on bullocks.

No doubt some useful isolated research work on forage and fodder crops was done in the past by different state and central agencies but this national problem called for an urgent, purposeful, unified and co-ordinated, production-oriented approach. The need was thus felt for a central organisation exclusively devoted to researches on grassland and fodder crops, their production, utilization, conservation and other aspects related to increased animal production drive.

Recognition of the importance of forage in feeding the livestock, the increasing gap between the supply and demand of forage and the diversity and complexity of the problems, led the Government of India and Indian Council of Agricultural Research to establish the Indian Grassland and Fodder Research Institute at Jhansi in 1962.

OBJECTIVES

The Institute has the following six-fold major objectives :

1. To carry out research, both of basic and applied nature on grasses, grasslands and fodder crops as related to sustained production of high quality fodder for efficient animal production, maintenance of soil fertility and crop production.
2. To evolve high-yielding, fertilizer-responsive, disease- and pest-resistant and superior quality forage and fodder crop varieties suited for different agroclimatic regions of the country by the use of modern techniques of

plant breeding and through the application of research in other cognate disciplines.

3. "To study all aspects of the problems of weeds in cultivated fodder, food and cash crops and grasslands and evolve economic measures of their control.
4. To design and fabricate efficient, low cost, labour-saving farm machinery and implements from indigenous materials to meet the diverse needs, with special reference to forage cultivation in small farm holdings.
5. To collect, co-ordinate and collate research work on the subject in the country by centralizing direction/operation and superintendence.
6. To disseminate knowledge on the subject through organised training programme and conduct large scale forage demonstrations at national level.

ORGANIZATION

For successful implementation of the above objectives of the Institute through a comprehensive multidisciplinary, problem-and production-oriented research programme, the Institute is currently organized into five technical Divisions, viz., (1) Plant Improvement, (2) Soil Science and Agronomy, (3) Grassland Management, (4) Plant-Animal Relationship and (5) Weed Ecology and Control and four Sections, namely, Agricultural Economics and Statistics, Agricultural Engineering, Cartography and Farm. In addition to these a full-fledged Division of Extension and Economics has been approved during the Fourth Plan. The Agricultural Economics and Statistics Section will then form part of this Division.

The researches being carried out in these Divisions/Sections are well integrated and are directed to immediate problems in the field of forage production and utilization. Thus, the primary aim of researches undertaken in the Plant Improvement Division relates to evolving of superior (both in relation to quality and quantity and also other varied objectives specific for each crop) varieties of different forage crops by the use of modern techniques of plant breeding and through the application of research in other cognate disciplines. Similarly in the Soil Science and Agronomy Division, research efforts are underway to maximise fodder production per unit area per unit time through innovation and standardisation of suitable agronomic practices in the use of fertilizer application, soil-water management, cultural practices and micro-nutrient application both in respect of forage and seed production. The research activities of the Grassland Management Division are geared to the uplift of our denuded grasslands to ensure their full potentiality of production by evolving a package of practices for their improvement, management and efficient utilization. The Plant Animal Relationship Division concerns with finding out ways

and means for the achievement of enhanced and economical production of milk, meat and other animal products through the efficient utilisation of various forage crops. The researches on all aspects of weeds and their control both in fields under cultivated fodders and grasslands are underway in the Division of Weed Ecology and Control.

In these research efforts, all the four Sections make valuable contributions. In addition, the Agricultural Engineering Section is also engaged in design, fabrication and development of farm machinery for use in fodder crops and in grassland farming.

ALL-INDIA CO-ORDINATED PROJECTS

The Institute is also the home of some of the All-India Co-ordinated Research Programmes and it, therefore, acts as centre for direction, operation and/or superintendence of two major All-India Projects in the fields of Forage Production and Utilization and Economics of Milk Production. The former project has eight main centres and six sub-centres and the latter has nine centres located in different parts of the country. The co-ordinating units and the two project co-ordinators for these projects are located at this Institute. The Institute also participates in the National Demonstration scheme of the I. C. A. R. in which it conducts demonstration on forage crops in the farmer's fields all over country adopting improved package of agronomic practices standardized for maximising yield in improved varieties. A sub-centre of the All-India Scheme on Dryland Agriculture Farming is also located at this Institute. Under this, trials are being conducted using fodder crops under different soil conditions with rain water during *kharif* and also on conserved moisture during *rabi*. A unit of another All-India Scheme, *viz.*, Co-ordinated Agronomic Trials of the I.C.A.R. functioning at this Institute is devoted to study the nutrient response of various crops under different soil tracts. A sub-centre of the All-India Co-ordinated Project on fodder and grain *Sorghum* is also located at this Institute.

STAFF PATTERN

The Director is the technical and administrative head of the Institute. The Institute including Schemes has a sanctioned strength of 98 scientific and specialized personnel, 15 technical staff, 54 field staff and 60 administrative and office staff and 40 class IV including watch and ward staff. Several senior scientists have already joined the Institute to man the various laboratories and the remaining positions are being filled up on an All-India competition basis. During the year under report, the staff position in the various Divisions/Sections/Schemes is summarized below upto Research Assistant level as on 31-12-1971.

| <i>Designation</i> | <i>Name</i> | <i>Date of joining</i> |
|--------------------|------------------|------------------------|
| Director | Dr. M. L. Magoon | 10.6.1970 |
| P. A. to Director | Sri O. P. Dubey | 25.1.1971 |

PLANT IMPROVEMENT DIVISION

| | | |
|---|----------------------|--------------------------------|
| Head of Division | Dr. K. L. Mehra | 15.4.1967 |
| Botanist | Dr. A. P. Singh | 3.10.1967 (upto 11.9.1971) |
| Plant Breeder (Legumes) | Sri Amar Singh | 15.5.1969 |
| Plant Breeder (Grasses) | Dr. R. Krishnan | 12.10.1970 |
| Jr. Plant Pathologist | Dr. S. T. Ahmad | 6.2.1970 |
| Jr. Entomologist | Sri Shri Ram | 4.5.1970 |
| Jr. Plant Physiologist | Dr. O. P. Saxena | 8.9.1970 (upto 1.12. 1971) |
| Asstt. Plant Improvement Officer (Legumes) | Sri C. B. Singh | 11.7.1968 |
| Asstt. Plant Improvement Officer (Grasses) | Sri Bhag Mal | 15.7.1968 |
| Senior Research Asstt. | Sri M. S. Yadav | 22.2.1969 |
| Research Assistant | Sri Devendra Singh | 1.1.1968 |
| Research Assistant | Sri K. S. Kohli | 4.1.1968 |
| Research Assistant | Sri K. C. Velayudhan | 18.8.1969 |
| Research Assistant | Sri O. P. Dixit | 24.12.1966 (upto 24.1.1971) |

SOIL SCIENCE & AGRONOMY DIVISION

| | | |
|---|-----------------------|-------------------------------|
| Head of Division | Dr. C. T. Abichandani | 10.4.1968 (upto 16.8.1971) |
| Fodder Agronomist (Crop Husbandry) | Dr. M. N. Mishra | 30.9.1967 |
| Agronomist (Soil and Water Management) | Dr. S. B. Hukkeri | 5.4.1968 |
| Soil Scientist | Dr. N. D. Mannikar | 1.9.1969 |
| Asstt. Agronomist (C. H.) | Sri J. T. Karnani | 15.2.1967 |
| Asstt. Agronomist (S. W. M.) | Dr. R. K. Rajput | 21.12.1967 (upto 2.9.1971) |
| Senior Research Assistant | Sri A. S. Gill | 1.2.1969 (upto 23.8.1971) |
| Research Assistant | Sri Gopi Chandra | 5.1.1968 (upto 31.8.1971) |

| | | |
|--------------------|--------------------|-----------|
| Research Assistant | Sri N. P. Shukla | 15.1.1968 |
| Research Assistant | Sri S. N. Tripathi | 8.9.1969 |

GRASSLAND MANAGEMENT DIVISION

| | | |
|--------------------|---------------------------|------------|
| Head of Division | Sri P. M. Dabadghao | 1.11.1962 |
| Ecologist | Dr. K. A. Shankaranarayan | 3.1.1964 |
| Ecologist | Sri K. C. Kanodia | 22.9.1967 |
| Ecologist | Sri R. Debroy | 5.5.1970 |
| Asstt. Ecologist | Dr. Vinod Shankar | 31.7.1967 |
| Asstt. Ecologist | Dr. P. S. Pathak | 24.12.1969 |
| Asstt. Ecologist | Dr. P. K. Jayan | 25.2.1971 |
| Research Assistant | Sri V. S. Upadhyaya | 15.1.1968 |
| Research Assistant | Sri B. K. Trivedi | 11.8.1969 |
| Research Assistant | Sri Ravi Kumar Shashank | 22.9.1969 |

WEED ECOLOGY AND CONTROL DIVISION

| | | |
|----------------------------|----------------------|------------------|
| Head of Division | Dr. T. R. Dutta | 13.12.1967 |
| Agronomist (Weed Control) | Dr. R. P. Singh | 6.11.1967 |
| Organic Chemist | Dr. R. K. Gupta | 31.5.1969 |
| Asstt. Agronomist | Sri R. K. Pandey | 28.5.1968 |
| Asstt. Chemist | Sri A. K. Srivastava | 24.12.1969 |
| Asstt. Systematic Botanist | Dr. S. R. Gupta | 21.1.1970 |
| Senior Research Assistant | Sri O. P. S. Panwar | 27.11.1969 |
| Research Assistant | Sri Jalipa Prasad | 10.1.1968 |
| | | (upto 18.4.1971) |
| Research Assistant | Sri J. N. Gupta | 18.9.1969 |

PLANT ANIMAL RELATIONSHIP DIVISION

| | | |
|---------------------------|---------------------|------------------|
| Head of Division | Dr. R. Mukherjee | 12.6.1967 |
| Livestock Specialist | Dr. A. Rehib | 14.4.1969 |
| Jr. Analytical Chemist | Sri S. C. Gupta | 2.11.1970 |
| Senior Research Assistant | Sri A. P. Singh | 22.2.1969 |
| Research Assistant | Sri N. C. Verma | 10.1.1968 |
| Research Assistant | Sri Vijay Singh | 15.2.1968 |
| | | (upto 18.3.1971) |
| Livestock Assistant | Sri A. K. Dabadghao | 18.11.1969 |

ECONOMICS & EXTENSION DIVISION

| | | |
|-------------------------|--------------------|-----------|
| Statistician | Sri P. R. Sreenath | 8.5.1968 |
| Asstt. Agril. Economist | Sri H. H. Datta | 18.1.1968 |
| Research Assistant | Sri Ram Prakash | 4.11.1969 |

FARM SECTION

| | | |
|---------------------|-------------------|-----------|
| Farm Superintendent | Sri S. P. Marwaha | 15.2.1967 |
|---------------------|-------------------|-----------|

AGRICULTURAL ENGINEERING SECTION

| | | |
|-----------------------|-------------------|------------|
| Agricultural Engineer | Sri Jai Singh | 16.12.1969 |
| Land Surveyor | Sri H. B. Dhingra | 11.10.1971 |

CARTOGRAPHY SECTION

| | | |
|---------------------|---------------|----------|
| Junior Cartographer | Sri S. Pandey | 4.5.1971 |
|---------------------|---------------|----------|

ADMINISTRATIVE UNIT

| | | |
|------------------------|------------------|-----------|
| Administrative Officer | Sri A. S. Bhati | 25.2.1970 |
| Head Clerk | Sri H. C. Saxena | 3.12.1969 |

ACCOUNTS UNIT

| | | |
|-------------------|--------------------|-----------|
| Accounts Officer | Sri R. C. Saksena | 3.6.1969 |
| Junior Accountant | Sri J. N. Parashar | 16.3.1971 |

LIBRARY SECTION

| | | |
|-------------------|-------------------|----------|
| Library Assistant | Sri M. M. Rastogi | 1.5.1967 |
|-------------------|-------------------|----------|

ALL INDIA CO-ORDINATED TRIALS ON FORAGE PRODUCTION AND ITS UTILIZATION

| | | |
|---------------------------|-----------------|-----------|
| Project Co-ordinator | Dr. B. D. Patil | 9.8.1971 |
| Junior Statistician | Vacant | |
| Senior Research Assistant | Sri O. P. Dixit | 25.1.1971 |

ALL INDIA CO-ORDINATED AGRONOMIC TRIALS

| | | |
|-------------------|--------|--|
| Junior Agronomist | Vacant | |
|-------------------|--------|--|

ALL INDIA CO-ORDINATED TRIALS ON ECONOMICS OF MILK PRODUCTION

| | | |
|---------------------------|-----------------|----------|
| Project Co-ordinator | Vacant | |
| Veterinary Officer | Vacant | |
| Junior Agronomist | Vacant | |
| Junior Statistician | Vacant | |
| Senior Research Assistant | Sri N. C. Verma | 1.1.1971 |

ALL INDIA CO-ORDINATED PROJECT ON DRYLAND AGRICULTURE

| | | |
|-----------------------|--------|--|
| Agronomist | Vacant | |
| Junior Engineer | Vacant | |
| Junior Soil Physicist | Vacant | |

| | | |
|---------------------------|------------------|----------|
| Senior Research Assistant | Sri Gopi Chandra | 1.9.1971 |
| Senior Research Assistant | Vacant | |
| Senior Research Assistant | Vacant | |

ALL INDIA CO-ORDINATED PROJECT ON SORGHUM

| | |
|--------------------|--------|
| Junior Agronomist | Vacant |
| Junior Breeder | Vacant |
| Research Assistant | Vacant |
| Research Assistant | Vacant |

The year also witnessed changes in staff position with the joining of Dr. B. D. Patil as Project Co-ordinator, Sri S. Pandey as Junior Cartographer and Dr. P. K. Jayan as Assistant Ecologist ; departure of Drs. C. T. Abichandani (to C. A. Z. R. I., Jodhpur) R. K. Rajput (to C. S. S. R. I., Karnal) and O. P. Saxena (to Gujrat University, Ahmedabad) ; and retirement of Dr. R. Mukherjee, Head of the Division of Plant Animal Relationship.

Indian Grassland and Fodder Research Institute has been further strengthened by the provision of additional budget of Rs. 20 Lakhs and 49 scientific, 4 technical, 2 administrative and 5 medical staff during the Fourth Five Year Plan.

FACILITIES

(a) *Experimental Farm* : The Institute has about 575 hectares of experimental farm situated at a distance of about 8 km from the town of Jhansi on the Jhansi-Gwalior Road. The Farm is located in the transitional zone with contrasting soil types and varying topography. Following reconnaissance survey of soil and vegetation of the Farm for reclamation and development of land for experimental purposes, the research activities of the Institute began in 1965 with a nucleus staff. About 356 hectares are under natural grasslands and about 125 hectares have been brought undercultivated fodders. The Farm has a good potential for irrigation and supplementary source for irrigation water. There is also a well equipped meteorological observatory, located in the centre of Farm to provide data on weather conditions. It also has adequate farm buildings. The strength of livestock is also being progressively enlarged to meet the research requirements.

(b) *Laboratories* : The Institute is, at present, located in three rented buildings in the city of Jhansi which are being used as laboratories. These laboratories are being progressively equipped with modern equipments and other facilities so as to facilitate comprehensive and integrated research programme on diverse aspects of fodder production and its utilization.

The construction work of the new laboratories and administrative buildings at the campus site adjacent to experimental Farm is progressing well and a laboratory

wing and administrative block are expected to be handed over by the C. P. W. D. for occupation in mid-1972. A glass house with facilities for controlled conditions of temperature, humidity and light is also being constructed. The construction work of 61 residential quarters at the site, in the first phase, is also nearing completion and these quarters are likely to be made available for occupation around September, 1972. The works relating to laying out of roads, parks, sewage lines and drainage pipes, provision of water and electricity are also being completed. Construction work approved during the second phase is also proposed to be taken up soon.

(c) *Library* : Library facilities have been further expanded by procuring 286 books, 90 foreign scientific journals and 54 Indian scientific periodicals during this year. The number of books and back volumes of scientific journals so far obtained are 2206 and 400 respectively. These collections have also been strengthened by the addition of many reprints and publications of various types from different research institutions within the country and abroad. All these were properly catalogued and carefully maintained.

(d) *Museum* : An informative and instructive museum has been set up with over 100 maps, charts, diagrams and photographs depicting the research activities and achievements of the Institute. The live specimens and new farm implements have also been kept in the museum for the benefit of farmers.

(e) *Advanced Training of the staff* : Sri R. K. Pandey, Assistant Agronomist (W.C.), was deputed for advanced training in the field of weed control under the Colombo Plan for a period of nine months at Weed Research Organization, Oxford, U.K.

Three fellowships were also approved for the Institute under the UNDP Project (IND-42) for training of Indian counterpart personnel. Dr. K. A. Shankararayan, Ecologist, has been selected for training in grassland management for a period of four months at the Grassland Research Institute, Hurley, U. K., Sri A. P. Singh, Senior Research Assistant, for six months training in the field of fodder conservation at the Research Centre of Agriculture, Braunschweig, Volkenrode, West Germany and Sri C. B. Singh, Assistant Plant Improvement Officer (Legumes), for six months training in the field of tropical and sub-tropical seed production technology at Cunningham Laboratory, C. S. I. R. O., Queensland, Australia. These scientists are expected to proceed abroad for training shortly.

Twenty five fellowships have also been earmarked for training of the counterpart personnel in the various disciplines overseas during the Phase II of the UNDP Project (IND-42).

RESEARCH COLLABORATION AT NATIONAL LEVEL

In addition to participation in six All-India Co-ordinated Schemes referred to already, the Institute actively collaborated with the Institute of Agricultural Research Statistics, New Delhi for the implementation of the scheme on 'The Estimation of Area of Grazing land and its Utilization'. Collaboration was also established with Indian Agricultural Research Institute, New Delhi; National Dairy Research Institute, Karnal; Indian Veterinary Research Institute, Izatnagar; Central Arid Zone Research Institute, Jodhpur; Central Sheep and Wool Research Institute, Malpura; Punjab Agricultural University, Ludhiana; Haryana Agricultural University, Hissar; Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur and several research stations of the U.P. State in the conduct of trials on forage crops and for exchange of herbage material.

RESEARCH COLLABORATION AT INTERNATIONAL LEVEL

The United Nations Development Project on grassland and forage development in India (IND-42) has been in operation at this Institute since September, 1969 and under this project the Institute received assistance by way of expertise, equipments and fellowships for overseas training of the counterpart personnel.

EXTENSION AND EDUCATION

(a) *Advisory services* : Apart from the research and developmental activities, the facilities available at the Institute were also fully utilized in maintaining liaison between the cultivators, extension workers and research workers and rendering advisory service to interested agriculturists. Information on matters of technical and general nature pertaining to various aspects of cultivation of grasses and fodder crops was given to various parties which included farmers, private individuals, block development officers, students, state/central governments, universities, colleges and research institutes as and when approached as well as the necessary advice was also given to farmers and cultivators by visiting the different areas during the different phases of crop growth.

(b) *Technical Publications and Talks* : Fifty five research papers and articles of general interest pertaining to various aspects of forage production and utilization were written up for publication in different appropriate journals/presentation at different All-India Seminars/Conferences etc. to disseminate (see page 71) the results of research. Invited lectures were also given on various aspects of forage cultivation and utilization in the agricultural colleges and other places for the benefit of the interested growers/agricultural graduates and post-graduate students. A few talks were also given on improved methods of forage production and utilization from the All-India Radio for the benefit of cultivators.

(c) *Seed supply* : In response to requests from several state/central agencies and private organizations, varying quantities of seeds of forage crops were supplied during the year.

(d) *National Demonstrations* : Five National Demonstrations were conducted by the Institute on cultivators, holdings during the year. One of these demonstrations was laid out at Tikamgarh, neighbouring district of M. P. and the remaining four demonstrations were conducted in and around Jhansi. Fodder *Sorghum* (M. P. Chari) sown in one of the demonstrations gave 735 q/ha of green fodder in three cuttings taken in the growth period of 150 days. This averaged to a production of 4.9 q/ha/day of green fodder. The gross return was Rs. 24.50/ha/day.

A profitable method for chemical weed control in soyabean crop was demonstrated in farmers' fields in Nagpur which is a centre of soyabean-based agro-industries.

(f) *Training* : A training course was also organised at this Institute for imparting knowledge on the improved technology of forage production and utilization to the State Fodder Development Officers for the period from 15 to 27 February, 1971.

WORKSHOPS/CONFERENCES/SYMPOSIA

Research Staff of the Institute attended the following Workshops/Conferences/Symposia during the year 1971.

1. 58th Indian Science Congress held at Bangalore from 1—7 January, 1971.
2. International Symposium on Plant Pathology held at IARI, New Delhi from 24th January to 3rd February, 1971.
3. International Symposium on Soil Fertility Evaluation held at New Delhi from 9-13 February, 1971.
4. Refresher Training Programme for Officers working under All-India Co-ordinated Agronomic Experiments Scheme held at Punjab Agricultural University from 25—28 March, 1971.
5. Workshop on National Demonstrations from 4-7 April, 1971 held at IARI, New Delhi.
6. Second Workshop on Dryland Agricultural Research held at Hyderabad from 22—26 April, 1971.
7. First All-India Workshop on Economics of Milk Production from 30th April to 1st May held at Haryana Agricultural University, Hissar.
8. All-India *Sorghum* Workshop held at Jamnagar from 3-8 May, 1971.
9. Second All-India Workshop on Forage Production and Utilization from 23—25 June, 1971 held at IARI, New Delhi.

10. Workshop on Soil-Water Management, Cropping Pattern under River Valley Projects etc. held at the University of Agricultural Sciences, Bangalore from 13—18, September, 1971.
11. All-India Congress of Cytology and Genetics held at Chandigarh from 30th September to 4th October, 1971.
12. Seminar on Forages for Dairy Cattle held at NDRI, Karnal on 23rd October, 1971.

FINANCE

The Institute is provided with an adequate budget in proportion to its current stage of development. The actual expenditure incurred from January to December, 1971 is as follows :

| | Revenue Expenditure | Capital Expenditure | Total |
|----------|------------------------|------------------------|--------------|
| Plan | Rs. 12,24,576.71 | 2,88,100.00 | 15,12,676.71 |
| Non-Plan | Rs. 1,73,416.88 | — | 1,73,416.88 |
| Total | Rs. 13,97,993.59 | 2,88,100.00 | 16,86,093.59 |

After meeting the feed and fodder requirements of the livestock strength at our Farm, the total receipts from the sale of Farm produce amounted to Rs. 86,210.68.

VISITORS

Apart from visits of various groups of students, farmers, block development officers, extension workers and others to the experimental Farm and laboratories of the Institute, we had the benefit of the visits of a number of important dignitaries and distinguished persons during the period under report.

- | | |
|---|--|
| <ol style="list-style-type: none"> 1. Dr. B. Gopala Reddy, Governor, Uttar Pradesh, Lucknow. 2. Sri K. C. Sharma, Dy. Minister for Planning and General Administration, Uttar Pradesh, Lucknow. 3. Dr. Govind Das Richhariya, Member of Parliament, Jhansi. 4. Dr. B. P. Pal, FRS, Director General, I. C. A. R., Krishi Bhavan, New Delhi. | <ol style="list-style-type: none"> 5. Sri S. J. Majumdar, ICS, Additional Secretary, Ministry of Agriculture, Govt. of India, Krishi Bhavan, New Delhi. 6. Dr. J. S. Kanwar, Dy. Director General (SAE) I. C. A. R., Krishi Bhavan, New Delhi. |
|---|--|

7. Dr. B. K. Soni,
Dy. Director General (AS), Indian
Council of Agricultural Research,
Krishi Bhavan, New Delhi.
8. Prof. Sir J. B. Hutchinson, FRS,
Plant Breeding Department,
University of Cambridge, U. K.
9. Dr. H. C. Pereira, FRS,
Member, British High Level Com-
mittee for Dryland Agriculture.
10. Dr. B. P. Pathekary,
Member, British High Level Com-
mittee for Dryland Agriculture.
11. Sri B. S. Mahajan,
Chief, Evaluation Service,
F. A. O., Rome.
12. Dr. J. J. Norris,
Range Management Section,
F. A. O., Rome.
13. Dr. W. J. A. Payne,
Consultant to the Administration,
U. N. D. P., Rome.
14. Sri Irwin Isenberg,
Assistant Resident Representative,
U. N. D. P., New Delhi.
15. Dr. H. Guyer,
Section for Fodder Production,
Swiss Federal Research Station for
Agronomy,
ZURICH-RECKENHOLZ,
8046, Zurich,
Reckenholz Strasse 191/211,
Switzerland.
16. Dr. G. H. W. Hutton,
Senior Agricultural Advisor,
F. A. O. Country Representative in
India, 21, Kasturba Gandhi Marg,
New Delhi-1
17. Sri R. Kuenzi,
Project Advisor, U. N. D. P. Project,
Shastri Bhavan, New Delhi.
18. Sri J. H. Thomas,
Farm Machinery Expert,
U. N. D. P. Project,
Shastri Bhavan, New Delhi.
19. Dr. F. D. Pettem,
Seed Production Expert,
U. N. D. P. Project,
Shastri Bhavan, New Delhi.
20. Sri F. Overgarrad,
Danish Nepal Project,
Kathmandu.
21. Dr. J. S. Patel,
Ex-Vice Chancellor and Ex-Agricul-
tural Commissioner,
Ministry of Agriculture,
Govt. of India, Baroda-7.
22. Dr. S. N. Ray,
Emeritus Scientist, I. C. A. R.,
College of Veterinary Medicine,
U. P. Agricultural University,
Pantnagar, U. P.
23. Dr. T. J. Mirchandani,
Regional Executive, F. C. I.,
305, Neelkant,
98, Marine Drive, Bombay.
24. Dr. L. S. Negi,
Vice Chancellor,
J. N. K. V. V., Jabalpur.
25. Dr. D. P. Motiramani,
Director of Research Services,
J. N. K. V. V.,
Jabalpur.
26. Dr. V. R. Bhalerao,
Assistant Director General, I.C.A.R.,
Krishi Bhawan, New Delhi.

27. Dr. Ch. Krishnamoorthy,
Assistant Director General-cum-
Project Director, (Dry Farming),
1-2-412/A Gagan Mahal Colony,
Hyderabad-29.
28. Dr. R. M. Acharya,
Director, Central Sheep & Wool
Research Institute,
Avikanagar (Malpura), Rajasthan.
29. Dr. A. N. Ghosh,
Dy. Commissioner (Fodders),
Ministry of Agriculture,
Govt. of India,
Krishi Bhavan, New Delhi.
30. Dr. G. P. Singh,
Asstt. Commissioner,
Ministry of Agriculture,
Govt. of India,
Krishi Bhavan, New Delhi.
31. Dr. K. R. Ahuja,
Deputy Director of Horticulture,
C. P. W. D., New Delhi.
32. Sri S. M. Ifrahim,
Commissioner,
Jhansi Division.
33. Sri N. M. Majmudar,
Collector, Jhansi.
34. Sri N. K. Chopra,
Regional Demonstration Station on
Forage Production, Hissar
35. Miss Cherry,
Journalist,
British Farm Service, U. K.
36. Sri K. Pillai, Shanti Bhawan,
Kaviyur, P. O. Tiruvalla, Kerala.
37. Block Development Officer of
Jhansi District.
38. Dr. N. Patnaik,
Asstt. Director General, I. C. A. R.,
Krishi Bhavan, New Delhi.
39. Dr. K. G. Tejwani,
Chief Scientist,
Soil Conservation and Training
Centre, Dehradun.
40. Shri S. J. Makhijani,
Deputy Commissioner,
Ministry of Food and Agriculture,
Krishi Bhavan, New Delhi.
41. Sri R. L. Relwani,
Associate Professor,
N. D. R. I., Karnal.
42. Dr. I. Mahapatra,
Physiologist,
I. V. R. I., Izatnagar.
43. Sri B. Joga Rao,
Defence Science Laboratory,
Metcafe House, New Delhi.
44. Dr. O. N. Mahotra,
Crop Physiologist,
Govt. of U. P.,
Kanpur-2.
45. Dr. V. R. Dyan Sagar,
Professor and Head,
Botany Department,
Nagpur University,
Nagpur.
46. Dr. A. Ansari,
Deputy Director, Animal Husbandry,
Jhansi.

VISITS ABROAD

Under the auspices of the F.A.O. and counterpart exchange programme of UNDP, Dr. M. L. Magoon, Director, visited several leading European institutes dealing with forages in Italy, Switzerland, West Germany, the Netherlands and U. K. with a view to studying the organizational pattern of the research institutes, working facilities including latest instrumentation, techniques and exchanging ideas with specialists. He also discussed with appropriate agencies for germplasm collections in connection with their possible utilization in the research programmes underway at the Institute.

HONOURS AND AWARDS

During the year under report, Dr. M. L. Magoon, Director, Indian Grassland and Fodder Research Institute, Jhansi continued to hold charge of the post of Director, Central Tuber Crops Research Institute, Trivandrum. Dr. M. L. Magoon is the recipient of a merit promotion effective from 1-1-1969 awarded by the Indian Council of Agricultural Research in recognition of his meritorious research achievements relating to the period 1966 to 1968 in the field of tuber crops amelioration at the Central Tuber Crops Research Institute, Trivandrum. This announcement was made by Council in 1971.

Dr. M. L. Magoon was India's representative at the Second International Symposium on Tropical Root and Tuber Crops held at the University of Hawaii, Honolulu, Hawaii, U. S. A. He chaired the session on Cassava.

Dr. M. L. Magoon has been elected President of the International Society for Root and Tuber crops. This unanimous election was made by the Second International Symposium on Tropical Root and Tuber crops held at the University of Hawaii, Honolulu, Hawaii, U. S. A.

WEATHER CONDITION AND CROP PROSPECTS

The year 1971 was, in general, a wet year. The total annual rainfall recorded at the Farm observatory during the year was 1431 mm which was 53 per cent more than the average rainfall of 936 mm per annum. The number of rainy days were 79 as compared to the average of 46 days per year. The period from January to May had negligible rains. *Rabi* crops were not damaged by frost or hailstorm. Monsoon started on 2nd June and the months of June, July and August experienced unusually excess rainfall totalling to 1132 mm about 80 per cent of the total rainfall of the year. This resulted in the excess of soil moisture conditions during the *Kharif* season. Therefore, fields with medium to heavy soils could not be sown. *Kharif* crops sown on light soils were also damaged due to excess rainfall. Similar difficulties were faced by cultivators as a result of excessive rainfall in and around Jhansi. The district of

Jhansi was, infact, declared as flood-affected area in 1971 by the State Government. Second, third and fourth weeks of September were dry. Monsoon receded on 18th October and rains received in late October were useful for field preparation for *rabi* sowings.

Weekly mean maximum temperatures ranged from 23.1 to 41.6°C and the minimum temperatures from 3.3 to 26.1°C with the maximum temperature of 43.9°C recorded on 8th May and the minimum temperature of 1.5°C observed on 3rd February.

The relative humidity was higher throughout the year ranging from 46 to 95 per cent. The weekly average rate of evaporation from std U. S. open pan evaporimeter ranged from 2.1 to 13.6 mm/day.

PROGRESS OF RESEARCH

The Institute pursued its various research projects relating to forage production and utilization as programmed by the Staff Research Council of the Institute and also approved by Indian Council of Agricultural Research, in proportion to the facilities built-up and staff strength available. The technical programme for the year 1971 alongwith salient features of research and their details are presented below :

TECHNICAL PROGRAMME 1971

Plant Improvement Division :

- PI-1 Introduction and preliminary evaluation of forage crops for fodder attributes.
- PI-2 Screening of germplasm collections of pasture grasses (a) *Cenchrus ciliaris* and (b) *Dichanthium annulatum*.
- PI-3 Screening of germplasm collections of forage legumes (a) Soybean (b) Berseem (c) *Vicia* and (d) *Stylosanthes*.
- PI-4 Screening of germplasm collections of *Sorghum* and oat.
- PI-5 Genetical studies in *Sorghum* and oat.
- PI-6 Cytogenetical studies in forage grasses (a) Irradiation studies (b) Screening of *Cenchrus* collections.
- PI-7 Breeding of improved varieties of forage *Sorghum* and oat through selection and/or hybridization.
- PI-8 Screening of germplasm collections of Cowpea, Metha, *Dolichos* and *Mucuna*.
- PI-9 Genetical studies in Cowpea.
- PI-10 Breeding of fodder cowpea, lucerne and *Arhar* through selection and hybridization.
- PI-15 Prevalence and distribution of plant diseases in forage crops.
- PI-16 Screening of germplasm collections against important diseases.
- PI-17 Determination of insect pests associated with forage crops around Jhansi.
- PI-18 Screening of germplasm collections of selected forage crops for resistance to pests. (a) Lucerne (b) *Guar* and (c) Cowpea.

Soil Science and Agronomy Division :

- SA-1 Evaluation of different fodders and varieties (*kharif* fodders)—Cowpea varieties.
- SA-2 Relative performance of different fodder varieties (perennial and *rabi* fodder)—(a) Hybrid napier (b) Tetraploid berseem.
- SA-3 Determination of optimum standards of cultural practices of important fodders crops (a) Seed rates of M. P. Chari (b) *Sarson* varieties for mixed sowing with berseem (c) Cutting management and nitrogen fertilization of M. P. Chari and Sudan grass.
- SA-4 Studies on soil fertility and fertilizer requirement of important fodder crops—(a) Late application of nitrogen in oats, (b) Nitrogen fertilization in relation to stage of cutting of oats, (c) Phosphate fertilization of berseem (d) Nitrogen sources for oats, (e) Nitrogen application in M. P. Chari under rainfed conditions, (f) Top dressing of N to soil, foliar application of spray grade and fertilizer grade urea and pre-emergence soil application of simazine in M. P. Chari (g) Spray grade urea application in oat (Kent).
- SA-5 Studies on irrigation requirements and water use of important fodder crops (a) Oat for seed under nitrogen fertilization (b) M. P. Chari, cowpea and *guar* sown pure and mixed (c) Cropping patterns for year round fodder production (d) Hybrid napier under varying plant density and nitrogen fertilization (e) Soil moisture stress on M. P. Chari.
- SA-6 Studies to improve seed yield of established fodders—(a) Micronutrient spray in berseem.
- SA-7 Studies on the feasibility and economics of introducing forage crops in cropping pattern—(a) Combination of perennial and annual fodders for year round fodder production (b) Cropping pattern for maximum fodder production per unit area per unit time.
- SA-9 Maximum production potential trial.

Grassland Management Division :

- GM-1 Manuring of grasslands—(a) Effect of N and P on *Heteropogen* grasslands (b) Effect of N and P on *Cenchrus ciliaris* and *C. setigerus* pastures.
- GM-4 Grazing management—(a) Relative grazing values of principal species of *Sehima-Dichanthium* cover (b) Continuous vs. deferred rotational system (c) Intensity and interval of cutting-cum-manuring studies on *Sehima nervosum*, *C. ciliaris* and *C. setigerus*.
- GM-6 Study on plant succession in grasslands—(a) *Sehima-Dichanthium* grass cover (b) Effect of burning on the botanical composition in *Sehima* grasslands.

- GM-7 Survey of grasslands—(a) Bundelkhand region—Jhansi district (b) Grassland herbarium.
- GM-8 Autecology of grassland species.
- GM-9 Evaluation of forest grazing resources of dry deciduous forests—Bundelkhand region.
- GM-10 Primary productivity of grassland ecosystem.
- GM-11 (a) Silvipastoral studies (b) Silvicultural studies.

Weed Ecology and Control Division :

- WE-1 Control of weeds of grassland—(a) *Heteropogon contortus* and (b) *Dichanthium annulatum* and *Iseilema laxum*.
- WE-3 Control of annual weeds of *rabi* season—(a) Wheat + mustard (b) Spinach and coriander.
- WE-4 Control of annual weeds of *kharif* season (a) Black gram and green gram (b) Soybean (c) Maiz + cowpea—wheat rotation (d) *Bhindi* (e) Jute (f) Residual effects.
- WE-6 Evaluation of herbicides—(a) *rabi* crops (b) Jute (c) Rice (d) Vegetable crops (e) *Parthenium hysterophorus* and (f) Synthesis of analogues.
- WE-7 Survey and collection of weeds from different agro-climatic regions of the country.
- WE-9 Produce quality and phytotoxicity as affected by herbicide application (a) Toxicity and (b) Chemical composition.

Plant Animal Relationship Division :

- PAR-2 Studies on the nutritive value of important forage crops—M. P. chari and hybrid jowar (Swarna).
- PAR-3 Studies on the nutrient yield and possible toxic and other physiologically active constituents in forage crops (a) Berseem varieties (b) Lucerne varieties (c) Oat varieties (d) Oat under nitrogen and phosphate fertilization (e) Lucerne with phosphate and potash fertilization (f) Berseem and oat in crop rotation for high fodder production and (g) *Sehima* and *Heteropogon* grasses at different stages of growth.
- PAR-4 Studies on the effect of feeding important fodder and forage crops on rumen metabolism and efficiency of milk production.

Extension and Economics Division :

- AES-1 Study on year to year cost of cultivation of general crops (*kharif* and *rabi*) in the Central Research Farm.

AES-3 Studies on the economics of milk production.

AES-4 Allied studies in the Central Research Farm (a) Economics of multiple cropping (b) Bullock maintenance cost (c) Tractor operation.

Agricultural Engineering Section :

AE-1 Design, development and evaluation of forage seed collectors and harvestors (a) Grass seed collector (b) Tractor-drawn irrigation Channel-cum-Bund Former (c) Mechanical chicory seed separator from berseem seed and (d) Effect of mechanical harvesting on regeneration and production of multi-cut fodder crops.

Cartography Section :

CS-1 Thematic cartography—for grassland mapping.

CS-2 Cartographic scales and symbols.

PLANT IMPROVEMENT DIVISION

Salient features :

Critical screening and comprehensive yield trials using materials from the large germplasm bank of forage crops led to the identification of superior selections in several forage crops.

A selection, IGFRI-S-3108 of *Cenchrus ciliaris* gave significantly higher green fodder yield of 403 q/ha in two cuts as compared to 307 q/ha produced by Pusa Giant Anjan under rainfed conditions in the third year.

In *Dichanthium annulatum*, selections, IGFRI-S-495-1 and IGFRI-S-495-5 were found promising, giving cumulative yields of 758 and 737 q/ha of green fodder as compared to 648 q/ha in control (Marvel-8) in three years under rainfed conditions.

Green fodder yields of fodder *Sorghum* selections, IGFRI-S-427, IGFRI-S-354 and IGFRI-S-452 were higher than that of M. P. Chari by 54, 26 and 23 per cent, respectively when cut at 50 per cent flowering stage in *kharif*.

Among thirteen promising selections of oats evaluated for their green fodder yield, IGFRI-S-3021 (442 q/ha) was superior to kent (389 p/ha) when cut at 50 per cent bloom stage while IGFRI-S-3021 (472 q/ha) and IGFRI-S-3008 (460 q/ha) were superior green fodder yielders to kent (369 q/ha) when cut twice (after 80 and 120 days of sowing).

In the trials conducted under All-India Co-ordinated Project at Jhansi, IGFRI-S-3 (224 q/ha) of *Sorghum* was the highest yielder when cut at the 50 per cent flowering stage ; IGFRI-S-271 and IGFRI-S-272 were superior with 417 and 410 q/ha of green fodder yields, respectively as compared to 389 q/ha produced by Sirsa-9, in 3 cuts taken during the first year in lucerne. Two cowpea selections IGFRI-S-998 and IGFRI-S-138 produced 92.8 and 83.8 per cent, respectively more fodder than the control variety FOS-1 in a single cut taken at pod initiation stage in the initial evaluation trial ; four selections IGFRI-S-457, IGFRI-S-515, IGFRI-S-978 and IGFRI-S-985 evaluated in the final evaluation trial, were found superior to the control variety, Sirsa-10 in dry-matter (per cent) and green fodder yield ; IGFRI-S-99-1, a berseem selection from Jhansi proved superior to Pusa Giant Berseem in green fodder yield at Hissar, Anand, Jabalpur and Palampur.

Seed dressing with carbofuran (4 per cent a. i.) proved an effective protectant for *Sorghum* against shootfly and for cowpea against leaf hopper, flea beetle and semilooper. Systematic screening of a world collection of 500 cowpea cultivars for

the field resistance to flea beetle, semilooper and leaf hopper resulted in identification of field resistant lines for one or more of the three pests.

As a result of systematic screening for disease reaction in germplasm collection of forage crops, 48 strains of cowpea, manifesting field resistance to leaf spot and virus, and one strain in lucerne showing field resistance to rust and leaf spot have been identified. Leaf spot and powdery mildew on lucerne, powdery mildew on metha and mosaic diseases in cowpea, *Dolichos lablab*, soybean and guar were recorded.

RESEARCH WORK DONE

The activities of this Division relate to breeding of important forage grasses and legumes and studies on the important diseases and pests infesting them and their control measures.

PI-1 : INTRODUCTION AND PRELIMINARY EVALUATION OF FORAGE CROPS FOR FODDER ATTRIBUTES
(A. P. Singh)

Additional 34 grasses and 176 legumes were collected, bringing the total germplasm collections of grasses to 4108 and legumes to 4321.

PI-2 : SCREENING OF GERMPLASM COLLECTIONS OF PASTURE GRASSES
(M. S. Yadav)

Cenchrus ciliaris :

Yield performance of 26 entries, during third year of their growth, in two cuttings taken in the months of August and November, 1971, was assessed in replicated trial. IGFRI-S-3108 gave significantly higher cumulative green fodder yield (403 q/ha) than the control Pusa Giant Anjan (307 q/ha). During the earlier years, i. e. in the year of establishment and the second year also, performance of IGFRI-S-3108 was superior to that of Pusa Giant Anjan. This selection is further characterized by minimum seedling mortality, better seed setting and quicker regrowth than that of Pusa Giant Anjan.

In another trial conducted during *kharif*, 1971 with 23 new collections and 5 high yielding selections, isolated from the above, IGFRI-S-3108 gave maximum yield (164 q/ha) and its yield difference with that of control variety, Pusa Giant Anjan (114 q/ha), was significant. IGFRI-S-8-1, IGFRI-S-59, IGFRI-S-3132, IGFRI-S-3813, IGFRI-S-3059, IGFRI-S-3740, IGFRI-S-3801, IGFRI-S-3802, IGFRI-S-4007 and IGFRI-S-4109 were also promising and they all gave higher (but not significant) yields than Pusa Giant Anjan.

Dichanthium annulatum

Based on cumulative green fodder yields of three years in 13 selections, IGFRI-S-495-1 and IGFRI-S-495-5 were found promising and gave green fodder yields of 758 and 737 q/ha, respectively as against 648 q/ha in the control variety Marvel-8. In respect of yield data of individual years also, their performance was superior to the control.

A separate trial comprising of 13 new collections and 5 high yielding types from the above trial was conducted during *kharif*, 1971. In the first cut taken in November, IGFRI-S-495-1, IGFRI-S-495-5, IGFRI-S-495-10, IGFRI-S-2518 and IGFRI-S-3995 yielded 70 to 87 q/ha as compared to 50 q/ha produced by the control-Marvel-8.

PI-3 : SCREENING OF GERMPASM COLLECTIONS OF FORAGE LEGUMES

(M. S. Yadav and K. L. Mehra)

Soybean

Evaluation of thirty six promising selections in a replicated trial during *kharif* 1971 at 50 per cent flowering stage, revealed that IGFRI-S-2072 gave maximum green fodder yield (386 q/ha) followed by IGFRI-S-758, IGFRI-S-772, IGFRI-S-2212, IGFRI-1884 and IGFRI-S-1885 giving 353, 332, 329, 320 and 312 q/ha green fodder yield, respectively.

Berseem

Twenty five collections along with Pusa Giant Berseem, as control, are being evaluated under three levels of phosphate (40, 80, 120 kg P₂O₅/ha), two heights of cutting (5 and 10 cm) and two intensities of cutting (25 and 40 days). Data on tiller number, plant height, stem girth, leaf number, leaf size, leaf-stem ratio and dry-matter (per cent) are being recorded at each cut.

Forty five selections with Pusa Giant Berseem (control) are being further screened on the basis of their fodder yields in progeny row trial.

Vicia

Fourteen collections of *Vicia* species were sown pure and mixed with oat (variety kent) for evaluation of their performance. The data on the green fodder yield and other quantitative traits and nutrient content of the green fodder of *Vicia* species and oat are being recorded.

Stylosanthes

Preliminary evaluation trial of twenty *Stylosanthes* collections representing four species *viz.*, *S. humilis*, *S. gracilis*, *S. sundaica* and *S. mucronata* as pure stand and in mixture with *Cenchrus* was initiated and the data on green fodder yield are being recorded.

PI-4 : SCREENING OF GERMPLASM COLLECTIONS OF SORGHUM AND OAT

(D. S. Katiyar and Bhag Mal)

Sorghum

Fodder attributes of 277 germplasm collections grown in 3 m long rows were recorded. A wide range of variation was observed in several characters. The variation was from 90 to 490 cm in plant height, 6 to 31 in leaf number, 35 to 100 cm in leaf length, 3.5 to 11.0 cm in leaf width, 3.1 to 28.0 per cent in sugar content, 35 to 185 days for 50 per cent blooming and 55 to 1655 g in green fodder yield per plant. Based on the overall superiority for these characters, seven promising cultivars were selected for inclusion in the preliminary yield trials.

Oat

Fifty two recent additions of oat collections screened for several fodder attributes at 50 per cent bloom stage showed variations in the plant height (64 to 160 cm), leaf number/tiller (4 to 10), stem thickness (0.33 to 0.80 cm), leaf length (9.1 to 47.0 cm), leaf width (1.05 to 2.60 cm), tiller number/plant (7 to 38) and green fodder yield/plant (50 to 700 g).

PI-5 : GENETICAL STUDIES IN SORGHUM AND OAT

(Bhag Mal and R. Krishnan)

Sorghum

Heritability and correlations were worked out, and factor analysis of fodder yield components was carried out using 48 varieties of forage *Sorghum* (*Sorghum bicolor* (Linn.) Moench.). The genotypic and phenotypic coefficients of variability were high to moderate. The varietal means for the days to bloom, plant height, stem girth, leaf number, leaf length, leaf width, leaf/stem ratio and fodder yield differed significantly. The heritability and per cent genetic advance of these characters ranged from 37 to 79 and 7 to 56, respectively. The high heritability accompanied moderate genetic gain for stem girth, leaf number, leaf width and fodder yield.

All characters showed significant, positive correlations except leaf/stem ratio which showed significant, negative correlation with fodder yield. The plant height, stem girth, leaf number, leaf length and leaf width were significantly positively correlated with each other. The partial correlation coefficients between fodder yield-stem girth and fodder yield-leaf length were significant. The multiple correlation coefficient revealed that 81 per cent of the variability in the fodder yield could be accounted for by the variability in the stem girth, leaf number, leaf length and leaf width. The factor analysis, however, revealed that one common causative factor seemed responsible for the high inter-correlations between the fodder yield, stem girth, leaf width and leaf number. Based on these studies, it is concluded that the

breeders should aim at the improvement of stem girth, leaf number and leaf width, for achieving improvement in the fodder yield in *Sorghum*.

Oat

The phenotypic, genotypic and environmental correlations and the partial and multiple correlations between the green fodder yield and its components were worked out in 25 varieties of oat (*Avena sativa* L.). The environmental correlations between most of the characters were lower than their phenotypic and genotypic correlations. Significant positive genotypic and phenotypic correlations were observed between the green fodder yield, plant height, stem girth, leaf length and leaf width. The green fodder yield, however, showed significant, negative phenotypic and genotypic correlations with the days to bloom and leaf number. The partial correlations revealed that when the effects of the other characters were eliminated, the correlation coefficients of the fodder yield with the days to bloom and plant height decreased slightly, whereas those with the stem girth, leaf length and leaf width decreased considerably. The multiple correlation coefficient, taking the fodder yield as a dependent variable and the remaining characters as independent variables, however, revealed that about 57 per cent of the variability in the fodder yield could be accounted for by the variability in the days to bloom, plant height, stem girth, leaf length and leaf width. Based on the results of simple, partial and multiple correlations, it was concluded that more emphasis should be put on the improvement of the plant height as compared to other characters, for improving the fodder yield in oat.

Other grasses

(M. S. Yadav)

Pennisetum pedicellatum : Heritability, genetic advance and correlations among ten fodder yield components were analysed in 36 selections. Heritability and genetic advance ranged from 28.8 to 97.0 and 10.5 to 31.3 per cent, respectively. The tiller number, leaf number, stem girth and fodder yield exhibited comparatively high heritability and high genetic advance. At both genotypic and phenotypic levels, the fodder yield was correlated significantly and positively with the days to bloom, tiller number and stem girth. The partial correlation coefficients between all character combinations except the days to bloom with stem girth, were significant. The multiple correlation coefficient taking the fodder yield as a dependent variable and the days to bloom, tiller number and stem girth as independent variable was 0.89.

PI-6 : CYTOGENETICAL STUDIES IN FORAGE GRASSES

(R. Krishnan and K. C. Velayudhan)

Irradiation studies

The data on the germination, general vigour, tiller number, days to inflorescence emergence, pollen fertility and seed characters were recorded in the irradiated

populations of *Avena sativa* and *A. fatua* (doses being 15, 18 and 21 kr) and in the untreated controls. The seeds of irradiated plants were collected separately, sown plant-and tiller-wise alongwith the controls, and further studies are in progress.

Screening of Cenchrus collections

Studies on the determination of chromosomal make-up and meiotic behaviour of several collections of both *C. ciliaris* and *C. setigerus* revealed variations in the chromosome number of *C. ciliaris* collections and occurrence of meiotic abnormalities.

PI-7 : BREEDING OF IMPROVED VARIETIES OF FORAGE SORGHUM AND OAT THROUGH SELECTION AND/OR HYBRIDIZATION

(M. L. Magoon, K. L. Mehra, R. Krishnan, Bhag Mal and D. S. Katiyar)

Sorghum

(a) Evaluation

Six selections and three hybrids were evaluated alongwith the control variety M. P. Chari for their yield performance when cut at the 50 per cent flowering stage. The data on their green fodder yield, leafiness and sugar content were recorded. A selection IGFRI-S-427 (234 q/ha) significantly outyielded M. P. Chari (152 q/ha) in the green fodder yield. The over-all yield performance in this year was low due to adverse climatic conditions as detailed in page 14. Among others, selections IGFRI-S-354 and IGFRI-S-452 gave 26.3 and 23.4 per cent higher green fodder yield over that of M. P. Chari. The selections excelling M. P. Chari in leafiness were IGFRI-S-309, IGFRI-S-332, IGFRI-S-427, IGFRI-S-452 and hybrid 2908 × 702; and those in sugar content were IGFRI-S-309, IGFRI-S-427 and hybrids 2908 × M. P. Chari and 2914 × 702.

The performance of nine promising selections, when cut twice (45 and 100 days after sowing) was evaluated in a trial, using M. P. Chari as control. The difference in the cumulative green fodder yield of the highest yielding selection IGFRI-S-700 and M. P. Chari was not significant. Four other selections, namely, IGFRI-S-79, IGFRI-S-352, IGFRI-S-702 and IGFRI-S-758 were also at par with them. In the first cut, there were no significant differences in the yields of the selections and of M. P. Chari. However, in the second cut, IGFRI-S-79, IGFRI-S-700 and IGFRI-S-758 gave significantly higher yields than that of the control.

(b) Advancing of the hybrid generations

Thirty one F_1 inter-varietal hybrids involving superior selections and M. P. Chari produced in the previous season, were grown alongwith their parents, and a comparative study of fodder attributes of parents and hybrids was made.

The selected progenies of the segregating generations of the inter-varietal hybrids were raised alongwith their parents and their fodder yield characters studied. These progenies were drawn from 20 F_2 , 25 F_4 and 5 F_5 hybrids.

Oat**(a) Evaluation**

Thirteen promising selections were evaluated along with the control variety kent for their yield performance when cut at the 50 per cent flowering stage. The data on the green fodder yield, leafiness, dry matter (per cent), plant height and days to 50 per cent bloom were recorded. The differences in the green fodder yields of these varieties were not significant. Selections IGFRI-S-3021 (442 q/ha), IGFRI-S-3010 (410 q/ha) and IGFRI-S-3026 (400 q/ha) outyielded kent (389 q/ha). The maximum dry-matter content of 26.9 per cent was recorded in IGFRI-S-2703. The selections, IGFRI-S-3008, IGFRI-S-3015, IGFRI-S-3021, IGFRI-S-3026 and kent were very leafy, while IGFRI-S-2682 and IGFRI-S-2705 were early blooming.

The selections included in the single-cut trial mentioned above were also evaluated for their fodder yield performance when cut twice (80 and 140 days after sowing). The differences among the varietal yields in the first and second cuts were significant but there were no significant differences in their cumulative yields. The selection IGFRI-S-3021 (330 q/ha) was significantly superior to kent (227 q/ha) in the first cut, while in the second cut IGFRI-S-3018 with 174 q/ha was superior to kent (142 q/ha). The other promising selections giving higher yields than kent in the 1st cut were, IGFRI-S-2682, IGFRI-S-2705, IGFRI-S-3008 and IGFRI-S-3014; 2nd cut were IGFRI-S-2703 and IGFRI-S-3008. On the basis of cumulative yields, IGFRI-S-3021 (472 q/ha), IGFRI-S-3008 (406 q/ha) and IGFRI-S-3014 (400 q/ha) were promising. Besides kent, high dry-matter containing selections were IGFRI-S-3018 and IGFRI-S-3010 in the first cut and IGFRI-S-2682 in the second cut.

(b) Hybridization

The seeds harvested from several successful controlled pollinations made between the selected stocks possessing desirable traits were sown.

Interspecific crosses were also made among hexaploid species, namely *A. sativa*, *A. byzantina* and *A. fatua*, with a view to transferring from the latter species the genes governing resistance to lodging, diseases and pests into *A. sativa*. The seeds harvested have also been sown.

(c) Advancing of the hybrid generations

The F₁ hybrids made in 1970, using the widely adapted variety kent and a few other materials possessing specific desirable attributes, were studied along with their parents. The seeds obtained from these plants have been sown.

F₂ generations of 7 crosses made during 1969 were raised and the individual plants studied for various characters, viz., plant height, tiller number, stem girth, leaf

number, leaf length, leaf width, leaf/stem ratio, green fodder yield and dry-matter per cent of best developed tiller alongwith a few qualitative characters. The selection was practised amongst the F₂ plants, and the promising ones were sown in the current *rabi* season, for further studies.

PI-8 : SCREENING OF GERmplasm COLLECTIONS OF COWPEA, METHA DOLICHOS, AND MUCUNA

(K. S. Kohli and Amar Singh)

Germplasm collections (410) of cowpea (*Vigna unguiculata*) were evaluated in single rows for quick growth, vigour, and leafiness. Thirty five promising lines showing faster rate of growth and superior leafiness were isolated for large scale testing.

In metha, 56 collections were subjected to preliminary evaluation and were screened for isolation for types superior in fodder yield and for powdery mildew resistance. Three lines showing tolerance to powdery mildew isolated for further testing.

Out of 24 germplasm collections of *Dolichos lablab* var. *lignosus* sown in 1970 and assessed for their yield and perennial habit, two strains showing vigorous growth combined with perennial habit were selected for further testing in association with the pasture grasses.

Out of 15 germplasm collections of *Mucuna cochinchinensis* evaluated in single rows for their fodder yield potential and seeding habit, two strains showing very vigorous growth and good seed-setting ability were isolated.

PI-9 : GENETICAL STUDIES IN COWPEA

(Amar Singh and C. B. Singh)

Thirty promising selections of cowpea were evaluated for their response to the application of phosphorus at 60, 90 and 120 kg P₂O₅/ha to isolate types responsive to high dosage of phosphorus application. The data collected on the various components contributing towards fodder yield and the total plot yields, indicated that all the strains responded to the higher applications of phosphorus upto 90 kg P₂O₅/ha.

A trial using the above said 30 promising selections was conducted to select types suitable for mixed cropping with M. P. Chari for meeting the protein requirements of the animals. Data recorded on various fodder yield components as well as on total fodder yield, revealed that the varieties behaved differently under mixed cropping. Taking the fodder yield of M. P. Chari constant per plot, the yield of mixture (M. P. Chari + cowpea) was boosted to 19.5, 17.5 and 13.9 per cent more than that of the control variety Russian Giant by the three strains namely IGFRI-S-475, IGFRI-S-1296 and IGFRI-S-457, respectively.

The phenotypic, genotypic and environmental correlations between fodder yield and its components were worked out in cultivars from 5 different geographical regions of the world. Significant positive correlations were observed amongst main branch length, number of primary branches, stem girth and leaf number and the green and dry fodder yields. The environmental correlation coefficients between most of the characters studied were lower than their phenotypic and genotypic correlation coefficients.

The factor analysis based on both genotypic and environmental correlation matrices also revealed that only one common causative factor seemed responsible for high correlation observed between these characters. It suggested that more emphasis should be laid in the improvement of main branch length and leaf number as compared to other characters for making improvement in fodder yield in cowpea.

Berseem

(M. S. Yadav)

Forty six collections were evaluated in a replicated trial. The fodder yield, primary branch length and tiller number exhibited wide range of variability. Both genotypic and phenotypic coefficients of variation were comparatively moderate for the secondary branches and low for the remaining characters. The heritability values were high for the secondary branches, fodder yield, primary branches, primary branch length and tiller number and moderate for the remaining characters. High heritability accompanied high genetic advance for secondary branches.

PI-10 : BREEDING OF FODDER COWPEA, LUCERNE AND ARHAR THROUGH SELECTION AND HYBRIDIZATION

(K. L. Mehra, M. L. Magoon, Amar Singh and C. B. Singh)

Cowpea

Twenty inter-varietal hybrids (F_1) made between the selected set of diverse parents were grown in single rows for preliminary observations. One F_1 hybrid of a cross involving IGFRI-S-457 and IGFRI-S-143 showed considerable heterosis and faster growth rate. Seeds from individual crosses have been collected for raising the F_2 generation.

Lucerne

Sixteen F_1 hybrids between the selected parents and back crossed progenies of IGFRI-S-244 and Sirsa-9 cross were grown for preliminary evaluation and isolation of superior types possessing quick regrowth and greater tillering ability.

Arhar

Forty eight inter-varietal hybrids (F_1) made between the selected diverse parents were grown for preliminary evaluation and advancing of hybrid generation for isolation of superior segregants.

PI-15 : PREVALENCE AND DISTRIBUTION OF PLANT DISEASES IN FORAGE CROPS

(S. T. Ahmad)

Periodical surveys of prevalence of plant disease at Central Research Farm, Jhansi, revealed the occurrence of leaf spot (*Paedopeziza* sp.), rust (*Uromyces striatus*), powdery mildew (*Erysiphe polygoni*) on lucerne. The attack of mildew was more severe this year as compared to that of previous year and more than 80 per cent of the crop was infested showing varying degrees of infection. The rust of lucerne appeared very late and the severity of the disease was less than 20 per cent. Other leaf spot diseases caused by species of *Cercospora* were found in traces on berseem and arhar and with moderate to high severity on cowpea. The attack of leaf spot caused by *Cercospora* sp. was heavy on guar and mild on sarson. This year also, all the methi collections were found susceptible to powdery mildew. Mosaic diseases were found on cowpea, *Dolichos* sp, soybean and guar, in decreasing order of severity. Among the bacterial diseases, bacterial pustule on soybean and leaf spot on cowpea, *Dolichos* sp. and guar were noticed.

Oat was found to harbour leaf spot, leaf blotch and red leaf virus with relative prevalence of 28-30, 10-12 and 2-4 per cent, respectively.

PI-16 : SCREENING OF GERmplasm COLLECTION AGAINST IMPORTANT DISEASES

(S. T. Ahmad)

The studies were confined to field screening only since facilities for screening under artificial epiphytotic conditions are still being developed. Germplasm collections of *Dolichos* sp. (25) were screened against *Dolichos* venation mosaic and leaf spot. All cultivars were susceptible to leaf spot. Only one cultivar, IGFRI-S-2228, was susceptible to virus disease.

Cowpea cultivars (410) were screened against pod spot, leaf spot, and mosaic virus. Forty eight cultivars were found free from the above diseases.

Lucerne cultivars (21) included in the co-ordinated trials, were screened against rust and leaf spot diseases. Syn-2, IGFRI-S-72 and IGFRI-S-258 were resistant to rust while IGFRI-S-49, IGFRI-S-54, Sirsa-9 and annual were resistant to leaf spot. The only selection resistant to both the diseases was IGFRI-S-59.

Thirteen different cultivars of berseem were found susceptible to leaf spot but free from root-rot.

Oat cultivars (195) were screened against leaf blight, leaf blotch and red leaf under field conditions. One hundred sixty eight cultivars were free from these diseases. Sixteen cultivars showed infection of leaf blotch, 17 cultivars exhibited leaf blight infection while three cultivars showed red leaf disease. Oat cultivars (24)

grown under the co-ordinated trials were also screened against leaf blight and red leaf diseases. Out of these, 20 cultivars were free from red leaf and two from leaf blight. Field resistance against the two diseases was found in IGFRI-S-2660 and IGFRI-S-3020.

Miscellaneous

To assess the losses caused by powdery mildew on *metha* and lucerne crops, 4 promising cultivars of *metha* (IGFRI-S-2306, IGFRI-S-2314, IGFRI-S-2333 and IGFRI-S-2336) and two of lucerne (IGFRI-S-244 and IGFRI-S-272) were grown. Spray with Dithane M-45, Dithane S-78, Tetracycline and Agrimycin, 40 days after sowing and repeated at 15 days interval, was used for controlling the disease. Data are being analysed on the following aspects : losses in green and dry weights, protein content, leaf size and plant height.

In a preliminary experiment, seeds of *guar* and soybean cultivars were screened through potato dextrose agar for the presence of fungal and bacterial diseases. Seeds infected with bacteria produced bacterial colony on the medium while, fungal infection could not be detected within a week. Effect of growth regulators (IAA, IBA, NAA and Ascorbic acid) were studied for the protection from seedling blight and control of *Alternaria* sp. in *guar*. The seeds were dipped in 100 ppm solution of the four chemicals for six hours. It was found that IAA, IBA and NAA could not check the seedling blight. Ascorbic acid was found to reduce the intensity of the seedling blight by 2-3 per cent. However, there was no effect of these chemicals on the development of leaf spot.

PI-17 : DETERMINATION OF INSECT PESTS ASSOCIATED WITH FORAGE CROPS AROUND JHANSI.

(Shri Ram)

Surveys to determine the associated insect pests and the extent of damage caused by them on various forage crops viz., cowpea, *guar*, soybean, *arhar*, *Dolichos lablab*, *Sorghum*, berseem, oat and lucerne were undertaken. Sixty two insect pests belonging to the order Orthoptera, Lepidoptera, Hemiptera, Homoptera, Coleptera, Diptera and a non-insect pest of the order Acarina were identified. The insect pest namely, flea beetle (*Pagria signata*), Semi-looper (*Plusia nigrisigna*) and leaf hopper (*Empoasca* sp. and *Exitianus indicus* in cowpea; yellow mite (*Polyphagotarsonemus latus*) and leaf roller (*Anarsia ephippias* in *guar*; leaf hopper (*Empoasca* sp.), flea beetle (*Monolepta* sp.), Whitefly (*Bemisia* sp.) and leaf roller (*Anarsia ephippias*) in soybean; flea beetle (*Pagria signata*) in *Dolichos lablab*; shoot fly (*Atherigona* sp.) in *Sorghum*, and leaf hopper (*Exitianus indicus*, *Empoasca* sp., *Austroagallia* sp., *Macrosteles* sp. and *Empoasca* sp.), aphid (*Aphis craccivora*), lucerne weevil (*Hypera postica*) and Thrips (*Aeolothrips collaris*) in lucerne were found to cause considerable loss to the crop.

Three insect pests, *viz.*, leaf-hopper, aphid and lucerne weevil were observed to cause considerable damage to lucerne crop. The incidence of these three pests started right from the 3rd week of November and continued till April. The incidence pattern of leaf hopper showed that the activity increased in the first week of December and declined thereafter. Activities of aphids and lucerne weevil, increased in the 3rd week of January and reached their peak during 3rd week of February, showing a declining trend thereafter. Thus, it appears that at least two sprays of insecticides are required, one in the second week of December, for controlling leaf hopper and the other in the 3rd or 4th week of January for control of aphids and lucerne weevil.

CONTROL MEASURES

Lucerne weevil and aphids.

A preliminary insecticidal trial was carried out with seven insecticides (0.04 per cent) *viz.*, Endosulfan, Malathion, Carbaryl, Trichlorphon, Mepazon, Dimethoate and Dichlorvos. All the insecticidal treatments were significantly superior to the control in controlling these two pests. Increase in the green fodder yields from 33 to 67 per cent over the control was recorded in treated plots which was, however, found not significant.

Sorghum shootfly.

A replicated insecticidal trial was carried out to test the relative performance of 5 insecticides, *viz.*, (i) Carbofuran (4 per cent a. i.) used as seed dressing. (ii) Carbaryl, (G 3 g/m), (iii) Phorate (G 1.5 g/m), (iv) Endosulfan (G 3 g/m) and (v) Thiodemeton (G 3 g/m) applied in seed furrows against shootfly on late sown crop. These insecticides reduced the incidence of the fly significantly as compared to that of the control. Among the chemicals, Carbofuran and Phorate were more effective than others. Thiodemeton was superior to Carbaryl and Endosulfan was least effective.

The per cent increase in green fodder yields over that of the control was maximum in Carbofuran (296) followed by Thiodemeton (250), Carbaryl (183), Phorate (154) and Endosulfan (142). The observed difference in yield between Carbofuran and Phorate treated plots, in spite of their comparable efficacy, was due to lowered germination in phorate treated plots.

Pests of Cowpea.

A field trial was laid out to test the relative performance of 4 insecticides, *viz.*, (i) Carbofuran seed treatment (4 per cent a. i.) (ii) Endosulfan (G 3 g/m), (iii) Phorate (G 1.5 g/m) and (iv) Carbaryl against the pests of cowpea. The results revealed that the insecticide, Carbofuran was significantly superior to others in checking the damage caused by leaf hopper, flea beetle and semilooper. Endosulfan and Phorate came next and were significantly superior to Carbaryl. There was no significant difference between plots treated with Carbaryl (G 3 g/m) and control.

The per cent increase in green fodder yield was maximum in Carbofuran (64.4) followed by Endosulfan (62.1), Phorate (52.7) and Carbaryl (22.7).

ESTIMATION OF LOSSES DUE TO PESTS IN GREEN FODDER YIELD OF COWPEA AND LUCERNE

(Shri Ram)

Separate experiments were laid out using paired plots for estimating losses due to pests in cowpea and lucerne crops. One of the plots was protected by using Carbofuran (4 per cent a.i.) and the other left for natural infestation. The results revealed that there was a loss of 30 and 37 per cent of green fodder yield in the untreated plots of cowpea and lucerne, respectively.

PI-18 : SCREENING OF GERMLASM COLLECTIONS OF SELECTED FORAGE CROPS FOR RESISTANCE TO PESTS

(Shri Ram)

Lucerne

Nineteen cultivars of lucerne grown in the co-ordinated trials were screened against aphids, weevil and leaf-hopper. The average population of leaf hopper varied between 11.1 (IGFRI-S-56) to 38.8 (IGFRI-S-272) per 10 sweeps. The extent of damage caused by lucerne weevil varied between 14.1 per cent in Syn-3 to 32.4 per cent in Syn-1. The average population of aphid per twig (of 4 cm size) varied between 4.8 (IGFRI-S-258) to 16.1 (IGFRI-S-271). The cultivar Syn-3 showed less infestation for the three pests studied,

Guar

Out of thirty eight cultivars of guar (*Cyamopsis tetragonoloba*) screened for resistance under field conditions against yellow mite (*Polyphagotarsonemus latus*), six cultivars namely, IGFRI-S-38, IGFRI-S-212, IGFRI-S-287, IGFRI-S-733, IGFRI-S-1538, and IGFRI-S-2382 appeared to be promising.

Cowpea

Screening of 500 cowpea collections obtained from the Indian sub-continent, USA and Latin America, Far-East, Middle-East and Africa indicated that although cultivars tolerant to pests occurred in all regions, proportionately higher percentage of cultivars showing tolerance to leaf hopper were the African, to flea beetle were the Far-Eastern and to semi-looper were the Middle-Eastern. The highest percentage of cultivars showing combined tolerance to leaf hopper+flea beetle were from the Indian sub-continent, both leaf hopper+semi-looper and flea beetle+semi-looper were from America and to all the three pests were from Middle-East. Proportionately higher percentage of cultivars from Nigeria showed tolerance to all the three pests as well as combined tolerance to flea beetle+semi-looper.

CO-ORDINATED TRIALS

The Institute was one of the centres for the All-India Co-ordinated Project on Forage Production and its Utilization. Several promising entries were contributed by this Institute for the following trials under this Project.

Sorghum

IGFRI-S-3, outyielded all other entries including the local control in the varietal trial. The overall yield performance of all the varieties was low owing to the unfavourable seasonal conditions. IGFRI-S-3 yielded 221 q/ha of green fodder as against yield range of 79 to 191 q/ha of the other entries when cut at the 50 per cent flowering stage.

Oat

In the evaluation trial-single cut, five entries from Jhansi and six from Hissar were evaluated for their yield performance in comparison with kent when cut at the 50 per cent flowering stage. The green fodder yield differences among varieties were not significant. Jhansi selection IGFRI-S-2672 (442 q/ha) was one of the two top yielding selections (the green fodder yield of kent being 337 q/ha).

The green fodder yield and dry-matter percentage of eleven entries (five from Jhansi and six from Hissar) along with those of kent, when cut at 60, 100 and 140 days after sowing, were assessed in the evaluation trial-multi-cut. The green matter yields ranged from 89 to 169 q/ha in the first, 178 to 230 q/ha in the second and 10 to 33 q/ha in the third cuts. The cumulative green fodder yield of different varieties ranged from 289 to 414 q/ha. However, the differences in the green fodder yield among varieties were significant only in the third cut, wherein the high yielders were FOS-1/20 (33.3 q/ha) from Hissar and IGFRI-S-14 (24.1 q/ha) from Jhansi. The control variety kent yielded 12.6 q/ha in the third cut.

Fifteen entries from Jhansi and ten from Hissar were evaluated in the initial evaluation trial-single-cut. The varietal differences in fodder yield were not significant. Out of the eight entries yielding 500 q/ha or above, six selections namely, IGFRI-S-2636 (608 q/ha), IGFRI-S-2681 (576 q/ha), IGFRI-S-3022 (560 q/ha), IGFRI-S-3010 (516 q/ha), IGFRI-S-3014 (506 q/ha) and IGFRI-S-3021 (500 q/ha) were from this Institute. Among the twelve entries with dry matter of 30 per cent and above, eight selections were IGFRI-S-2636, IGFRI-S-2674, IGFRI-S-3006, IGFRI-S-3010, IGFRI-S-3014, IGFRI-S-3015, IGFRI-S-3022 and IGFRI-S-3024 were from Jhansi. Selections, IGFRI-S-2635 and IGFRI-S-2681 were early flowering entries from Jhansi, which reached 50 per cent bloom stage in 100 days. Six entries possessing high percentage of leafiness (20 per cent and above) included four from Jhansi *viz.*, IGFRI-S-2635, IGFRI-S-2636, IGFRI-S-2681 and IGFRI-S-2692.

Berseem

Selection IGFRI-S-99-1 was found superior in green fodder yield outyielding the released variety, Pusa Gaint Berseem by 20.9, 13.2, 6.6, 4.0 at Hissar, Anand, Jhansi and Jabalpur locations, respectively.

Lucerne

An initial evaluation trial of lucerne conducted with 10 entries (9 from Jhansi and 1 from Hissar), revealed no significant differences amongst the strains in fodder yield in the individual cuts. However, in the overall fodder yield of 3 cuts, significant differences were observed. In over all fodder production, Syn-5 IGFRI-272, Syn-1 and Syn-4 outyielded the control variety Sirsa-9 by 11.2, 11.1, 11.0 and 10.8 per cent, respectively. In the individual cuts, though no significant differences were observed, but Syn-4, Syn-5 and IGFRI-S-272 were found superior to Sirsa-9.

The data recorded in the final evaluation trial of lucerne conducted with 12 entries (9 from Jhansi, 2 from Anand and 1 from Hissar) revealed significant differences amongst the varieties in the 2nd cut, while in the first and 3rd cuts and cumulative yield of 3 cuts, no significant differences were recorded. In the cumulative yield of 3 cuts, two selections namely, IGFRI-S-271 and IGFRI-S-272 gave 417 and 410 q/ha of green fodder yields, respectively as compared to 398 q/ha produced by Sirsa-9. In the individual cuts, IGFRI-S-271 was superior to Sirsa-9, though the differences were not significant.

Cowpea

In an initial evaluation trial of cowpea conducted with 26 entries (21 from Jhansi and 5 from other centres), it was observed that IGFRI-S-998 and IGFRI-S-138 produced 92.8 and 83.8 per cent (412 q/ha, 393 q/ha), respectively more fodder than the control variety FOS-1 (181.8 q/ha) in a single cut taken at pod initiation stage. Besides those, other entries, which were found promising, were IGFRI-S-144, IGFRI-S-1008 and IGFRI-S-986 which outyielded the control by 81, 72 and 63 per cent, respectively in fodder yield. The dry-matter was 12 per cent in IGFRI-S-998 and 16 per cent in IGFRI-S-138 in comparison with 13 per cent in the control.

The results of the final trial conducted with six entries of cowpea, revealed that all the 5 entries from Jhansi, outyielded the Sirsa-10 from Hissar by 57.2 to 77.5 per cent when the fodder was cut at pod initiation stage. The highest fodder yield was observed in IGFRI-S-978 (323 q/ha) followed by IGFRI-S-457 (273 q/ha) and IGFRI-S-985 (286 q/ha) as compared to the released variety Sirsa-10 (182 q/ha). The dry-matter content in these strains was 16.4, 13.4, 16.4 and 15.4 per cent, respectively as compared to 14.5 per cent observed in the control variety, Sirsa-10. In nutritive value, IGFRI-S-457, IGFRI-S-515 and IGFRI-S-985 were superior

with 18.9, 18.4 and 17.7 per cent crude protein to Sirsa-10 containing 17.3 per cent crude protein.

Research contemplated

1. Collections of indigenous forage grasses and legumes through various agencies, correspondence and seed collection trips will be intensified.
2. Efforts will be made to secure exotic collections through the Plant Introduction Division of I. A. R. I., New Delhi and other appropriate agencies.
3. Evaluation of cultivated legumes viz., guar (*Cyamopsis tetragonoloba*) and berseem (*Trifolium alexandrinum*) and also of range legumes viz., *Stylosanthes* spp., *Desmodium* spp., *Clitoria ternatea*, *Phaseolus atropurpureus* and *Glycine javanica* will be carried out.
4. Programme of variety construction for yield and quality in velvet bean, lucerne, cowpea and carpet legume will be intensified.
5. Production and quality breeding in fodder *Sorghum* and oats will be strengthened and in range grasses namely, *Cenchrus* and *Sehima*. such studies will be initiated.
6. Nature of resistance in lucerne for rusts/mildew, in cowpea for virus/leaf spot and in oats for rust/leaf spot will be analysed; control measures for diseases on forage crops will be standardized and the effect of plant diseases on the yield, quality and physiology of forage crops will be assessed.
7. Relative efficacy of common and safer pesticides and evaluation of losses in green fodder yield due to damage caused by major insect pests in major forage crops will be studied.

SOIL SCIENCE AND AGRONOMY DIVISION

Salient features :

For obtaining green fodder round the year, an overlapping cropping system of berseem+Japan *sarson* inter-planted with hybrid napier in spring and growing of cowpea in the inter-row spaces gave a total yield of 2863 q/ha green fodder during the period December, 1970 to November, 1971. This works out to a production of more than 7.8 q/ha/day green fodder.

In berseem (diploid), application of single and triple superphosphate were superior to rockphosphate. Highest green fodder yield of 1158 q/ha was obtained with 80 kg P_2O_5 /ha applied as triple superphosphate. This yield was obtained in five cuts during a growth period of 182 days.

For fodder oat (kent) calcium ammonium nitrate was found superior to ammonium sulphate, ammonium sulphate nitrate and urea as a source of nitrogen. Studies conducted on medium and light soils revealed that under both the soil conditions, green fodder yield of oat (kent) increased significantly with the increase in soil moisture and N levels. On medium soil, the response to higher levels of N was more pronounced under frequent irrigations (75 per cent A.S.M.) while on light soils, the response to higher levels of N was reduced under frequent irrigations.

The green fodder yield of M.P. Chari (fodder sorghum)+cowpea (746 q/ha) and M.P. Chari+*guar* (711 q/ha) was at par with the yield of pure summer sown M.P. Chari (734 q/ha in 4 cuts taken in 215 days). Thus, from the fodder quality point of view, growing of M.P. Chari mixed with legumes for fodder is better than growing it as a pure crop.

RESEARCH WORK DONE

SA-1 : EVALUATION OF DIFFERENT FODDERS AND VARIETIES (KHARIF FODDERS)
(Gopi Chandra and J. T. Karnani)

Cowpea varieties :

The trial with cowpea was continued for the second year with ten varieties viz., F. O. S. 1, Sirsa-10, No. 10, I. L. 143, C-57, F. S. 68, K-397, F. S. 146, E. C. 4216 and Russian Giant each tried under three levels (0,30 and 60 kg P_2O_5 /ha) of phosphate manuring.

The highest green fodder yield was obtained with Russian Giant variety (320 q/ha). However, there were no significant differences in the yields of the varieties

except that of F. S. 68, which yielded only 199 q/ha green fodder. Application of phosphorus increased the yield and the response was linear. The yields were 246, 284 and 317 q/ha green fodder under 0,30 and 60 kg P_2O_5 /ha respectively. There was no differential response of varieties to levels of phosphorus application.

Dry-matter yields of different varieties ranging from 27.8 (F. S. 68) to 45.6 q/ha (Russian Giant) followed similar pattern as the green fodder yields. There was no significant difference between these yields obtained at 30 kg P_2O_5 /ha (39.7 q/ha) and at 60 kg P_2O_5 /ha application (44.2 q/ha). The increase in dry-matter yields obtained with phosphate application over control (34.2 q/ha) were significant. There was no interaction between varieties and phosphate levels.

SA-2 : RELATIVE PERFORMANCE OF DIFFERENT FODDER VARIETIES (PERENNIAL AND RABI FODDERS)

(J. T. Karnani, M. N. Mishra and Gopi Chandra)

Hybrid napier :

This was the second year of the experiment. Fifteen napier \times bajra hybrids along with ordinary napier were tried under four levels of nitrogen, 150, 300, 450 and 600 kg N/ha. Nitrogen was given as split application, 1/3rd of full dose after first cut and rest in four equal instalments after each cutting. Total of six cuttings were taken. First cut was taken in the 3rd week of May and subsequent cuttings were taken after every 40 days.

Unlike last year, there were significant differences in the green fodder yields obtained due to varieties. The highest green fodder yield was obtained with N. B. 25 (1470 q/ha) followed by N. B. 35, N. B. 17, Pusa Giant, N. B. 3, N. B. 21 and hybrid napier Coimbatore (1334 q/ha) with which it was at par. Rest of the varieties gave significantly lower green fodder yields.

Nitrogen application gave significantly higher green fodder yield and the yield increased with higher N doses. The yield 1021 q/ha at 150 kg N/ha increased to 1602 q/ha at 600 kg N/ha. There was no differential response of varieties to nitrogen.

Tetraploid berseem

The trial was repeated for the third year and eight tetraploid strains obtained from I. A. R. I. along with diploid were each tried at two seed rates of 25 and 50 kg/ha with basal application of 20 kg N/ha and 100 kg P_2O_5 /ha. Three cuts were taken for fodder and the crop was left for seed production.

Results showed no significant differences between the different strains of tetraploid and diploid. The yield of green fodder in 3 cuts ranged from 419 q/ha of

Pusa Giant berseem to 466 q/ha of T. 678, and the seed yield from 342 kg/ha of T. 780 to 429 kg/ha of T. 678. There was no significant difference between the green fodder and seed yields due to the two seed rates. In general, the stand was affected due to fungal disease appearing in February. The interaction between strains and seed rates was also not significant.

SA-3 : DETERMINATION OF OPTIMUM STANDARDS OF CULTURAL PRACTICES OF IMPORTANT FODDER CROPS

(M. N. Mishra, J. T. Karnani and Gopi Chandra)

Seed rates of M. P. Chari

Six seed rates (30, 40, 50, 60, 70 and 80 kg/ha) were tried to find out the optimum seed rate for fodder production of M. P. Chari. The crop was sown on 9th July, 1971 and harvested after 75 days. Nitrogen at the rate of 60 kg N/ha and phosphorus at 50 kg P_2O_5 /ha were applied as basal dressing. Thirty kg nitrogen was top dressed after 30 days of sowing. The green fodder yields ranged from 155 q/ha (30 kg/ha) to 242 q/ha (80 kg/ha). Statistical analysis showed that there was no significant differences in green fodder yield obtained from 30 to 60 kg seed rate and between 70 and 80 kg seed rate. The green fodder yield increased significantly after 60 kg seed rate per hectare.

Sarson varieties for mixed sowing with berseem

Three varieties of *sarson* (Japan *sarson*, IM—98 and IM—100) were compared each at three different seed rates (0.5, 1.0 and 1.5 kg/ha) for mixed sowing with berseem with a view to obtaining higher green fodder yield in the first cutting. The crop was given a basal application of 20 kg N/ha and 100 kg P_2O_5 /ha. Results showed no significant difference in the green fodder yields in individual cuts as well as cumulative yields due to different varieties and seed rates tried. The total yield on the basis of five cuttings ranged from 705 q/ha for IM—100 to 728 q/ha for Japan *sarson* and 707 q/ha for 0.5 kg/ha seed rate to 728 q/ha for 1.5 kg/ha seed rate.

Cutting management and nitrogen fertilization of M. P. Chari and Sudan grass

This inter-institutional trial in collaboration with NDRI, Karnal included two stages of cutting and application of N ranging from 20 to 50 kg/ha after each cutting over a basal application of 60 kg N, 50 kg P_2O_5 and 40 kg K_2O /ha. Two cuttings were taken. Total green fodder yields obtained in M. P. Chari and Sudan grass were at par i. e. 419 and 405 q/ha, respectively. Harvesting the crop at 50 per cent flowering gave higher yield (480 q/ha) of green fodder than cutting at dough stage (344 q/ha). Application of 35 kg N/ha after cutting the crop resulted in the highest total yield of 424 q/ha which was 37.9 and 10.7 q/ha more than that due to 20 and 50 kg N/ha application, respectively.

SA-4 : STUDIES ON SOIL FERTILITY AND FERTILIZER REQUIREMENT OF IMPORTANT FODDER CROPS

(C. T. Abichandani, N. D. Mannikar, M. N. Mishra, J. T. Karnani, A. S. Gill, S. N. Tripathi and Gopi Chandra)

Late application of nitrogen in oat (kent)

The trial was repeated for the the second year. There were two treatment series with 60 and 40 kg N/ha basal application. 60 kg N/ha (basal) series received top dressing of N at 15 and 30 kg N/ha, each at 10 days before flag leaf and at flag leaf stage (75 and 85 days). 40 kg N (basal) series received 20 kg N/ha at 61 days after sowing. Further, this series also received 15 and 30 kg N/ha, each at 10 days before flag leaf and at flag leaf stage. The treatments 60 kg N/ha (basal) and 40 kg N/ha (basal) with 20 kg N/ha top dressed at 61 days after sowing were also tried as controls. Crop was harvested at 50 per cent flowering (104 days).

Results showed that the treatments differed significantly with respect to green fodder and dry matter yields. Both the series were statistically at par. The fodder yields increased significantly with increasing N levels, the increase being 27.0 q/ha green fodder (6.9 q/ha D. M.) obtained due to 30 kg N/ha over the yields (267 q/ha green fodder and 80 q/ha D. M.) at 15 kg N/ha. Time of N application was found to have no effect. The interaction was not significant.

Nitrogen fertilization in relation to stage of cutting of oat

Trial was repeated for the third year with modification that only one sowing date (27.10.1970) was tried. Treatments consisted of all combinations of (a) Cutting- (i) one cut at 50 per cent flowering, (ii) 2 cuts (one at boot stage and other at 50 per cent flowering; (b) N levels-30, 60, 90, 30+30 and 45+45 kg/ha. In the case of split application of N, second dose was given after first cut.

Results showed that unlike last year, cutting stage in addition to N application had a significant effect on green fodder and dry matter yields. The yields were significantly higher when two cuts were taken (398 q/ha G. M. ; 91.3 q/ha D. M.) than for single cut (330 q/ha G. M. ; 66.7 q/ha D. M.). Significant response to nitrogen was obtained upto 60 kg N/ha, recording an average increase of 56 q/ha green fodder and 17 q/ha dry matter over the yields obtained at 30 kg N/ha (306 q/ha G. M. and 63 q/ha D. M.) Split application of nitrogen had same effect on yield as single dose applied basal at sowing.

Phosphate fertilization of berseem

The trial was repeated for the third year using three sources of phosphatic fertilizers, namely, single and triple superphosphate and rockphosphate. The first two fertilizers were applied at the rate of 40, 80 and 120 kg P₂O₅/ha, while rockphosphate

was used at the rate of 80, 160 and 240 kg P_2O_5 /ha. Five cuts of berseem (diploid) were taken during the growth period of 182 days.

Results showed that like previous years, both sources of superphosphate were superior to rockphosphate. Among the superphosphate sources, triple superphosphate was more effective than the single superphosphate. Yield responses with single and triple superphosphate were statistically significant upto 80 kg P_2O_5 /ha giving green fodder yields upto 1022 and 1158 q/ha, respectively. These yields were 321 and 457 q/ha more than the control yield without P (701 q/ha). Significant increase of 147 q/ha green fodder was also obtained at 80 kg P_2O_5 /ha applied as rock-phosphate.

Nitrogen sources for oat (kent)

This trial was continued for the second year with 5 sources of N (ammonium sulphate, ammonium chloride, ammonium sulphate nitrate, urea and calcium ammonium nitrate) and N levels ranging from 30 to 120 kg N/ha. Like last year, calcium ammonium nitrate was significantly superior to ammonium sulphate, ammonium sulphate nitrate and urea in respect of green fodder and dry-matter yields. The average yields of green fodder and dry-matter obtained with calcium ammonium nitrate were 313.3 q/ha and 77.3 q/ha, respectively. Regarding the basal application of N, the yield increased upto 120 kg N/ha but significant increase of 73.3 q/ha green fodder (17.7 q/ha D. M.) was obtained upto 60 kg N/ha. Split application of N was in no way superior to the same dose applied as basal at sowing. The interaction between sources and levels of N was not significant.

Nitrogen application in M. P. Chari under rainfed conditions

Like last year, the trial was laid out separately on two different soils (Bhojla clay loam and Bharari sandy loam). Bhojla clay loam was having pH of 6.8, Org. C. 0.31 per cent and available P_2O_5 37 kg/ha and Bharari sandy loam had pH 7.0, Org. C. 0.68 per cent and available P_2O_5 13 kg/ha. The N treatments were 0, 30, 60 and 90 kg N/ha as basal application; additional treatments of 60 kg N/ha split in the ratio 1 : 1 and 90 kg N/ha split in the ratios of 2 : 1, 1 : 2 and 1 : 1 were also tried. Thirty kg P_2O_5 /ha was given as basal at sowing.

On Bhojla clay loam soil, the crop was sown on June 17, 1971 and harvested at 50 per cent heading on September 16, 1971. Only the difference (68.8 q/ha green fodder and 23.4 q/ha dry matter) between the yields obtained at 90 and 60 kg N per hectare applied as basal at sowing was found significant. Split application of 60 and 90 kg N/ha showed no added advantage over the same dose applied basal at sowing.

On Bharari sandy loam soil, the crop was sown on July 13, 1971 and harvested on September 21, 1971. Application of 30 kg N/ha resulted in significant increase of

40.3 q/ha green fodder over the control yield (without nitrogen) of 139 q/ha. The differences between the yields at 60 and 30 kg N/ha as well as 90 and 60 kg N/ha (entire dose applied as basal at sowing) were not significant. Sixty and 90 kg N/ha whether split applied or entire amount applied at sowing were equally effective. The treatment differences in dry-matter yields were also not significant.

Top dressing of N to soil, foliar application of spray grade and fertilizer grade urea and pre-emergence soil application of simazine in M. P. Chari

Trial was conducted for the second year on Bharari sandy loam soil (pH 7.0, Org. C. 0.68 per cent and available P_2O_5 13 kg/ha). All plots received a basal manuring of 60 kg N and 30 kg P_2O_5 /ha. Top dressing of N to soil as fertilizer grade urea (FGU) and foliar application of urea as both FGU and SGU (Spray Grade Urea) were tried each at 15 and 30 kg N/ha at boot stage. In addition, treatments on application of simazine at 100-500 g/ha were tried as pre-emergence soil application. Effect of the treatments was not significant either on green fodder or on dry matter yield. This may probably be due to abnormal rainfall (both in terms of amount and distribution) during the growth period of the crop. The yield ranged from 251 q/ha green fodder (109 q/ha D. M.) for control with 60 kg N/ha basal to 267 q/ha green fodder (114 q/ha D. M.) for 200 g/ha simazine application.

Spray grade urea and fertilizer grade urea application in oat (kent)

Trial was undertaken for the first year to compare the efficiency of spray grade urea (SGU) and fertilizer grade urea (FGU) using oat (kent) as test crop. Spray grade urea was obtained through the kind courtesy of M/s Shriram Fertilizers. Treatments comprised of all combinations of top dressing of 30 kg N/ha as FGU to soil and also as foliar spray using FGU and SGU each at 60, 75 and 90 days growth. A treatment of 60 kg N/ha (basal) was also included as control.

Results indicated that foliar application of SGU significantly increased the green fodder and dry matter yields by 42.0 and 14.0 q/ha over the yields 266 and 77 q/ha respectively obtained with top-dressed soil application of FGU. Spraying of FGU was statistically at par with soil application as regards green matter and dry matter yields. SGU was, however, significantly superior to FGU. The former produced 308 q/ha of green fodder (91.0 q/ha D. M.), while the latter yielded 282 q/ha of green fodder (82.1 q/ha D. M.). Differences in C. P. yield due to grades of urea or methods of application were not significant. Time of N application had no effect on fodder yields. The interaction between grades of urea and time of application was significant only with regard to green fodder and dry matter yields. The green fodder (312 and 313 q/ha) and dry matter yields (92.2 and 93.6 q/ha) obtained with SGU when sprayed at 60 and 75 days after sowing were higher than yields with other treatments.

SA-5 : STUDIES ON IRRIGATION REQUIREMENTS AND WATER USE OF IMPORTANT FODDER CROPS

(S. B. Hukkeri, R. K. Rajput and N. P. Shukla)

Oat for seed under nitrogen fertilization

Trial was repeated for the third year. Two separate trials, one on red gravelly sandy loam soil and other on deep loam soil, were laid out. Nitrogen at 30, 60 and 90 kg N/ha and irrigation at 25, 50 and 75 per cent A. S. M. (Available Soil Moisture) measured at 15-30 cm soil depth were tried. Nitrogen was given in split application half at sowing and half 30 days after sowing. Two cuts for fodder were taken, the first after about 95 days after sowing (50 per cent flowering) and the second after about 45 days after 1st cut. Crop on medium heavy soil was sown on 14-11-1970 and that on light soil on 27-11-1970 using kent variety.

Green fodder yield

Results showed that under both soil conditions green fodder yield of oat increased significantly due to increase in soil moisture and nitrogen levels. The interaction of irrigation levels \times nitrogen levels was significant on green fodder production of oat grown on both the soils. On medium heavy soil the response to higher levels of nitrogen was better pronounced under frequent irrigation (75 per cent A. S. M.), while on light soils the response to higher levels of nitrogen was reduced under frequent irrigation treatment. On medium heavy soil condition yield increases of 63 and 18 q/ha green fodder were obtained by irrigation at 75 per cent A. S. M. and 50 per cent A. S. M., respectively over the yield of 256 q/ha obtained under 25 per cent A. S. M. On light soil the yield increases under 75 per cent A. S. M. and 50 per cent A. S. M. treatments were 78 and 27 q/ha, respectively over 185 q/ha obtained under 25 per cent A. S. M.

Application of nitrogen at 90 kg N/ha recorded the highest green fodder yield of 354 q/ha on medium heavy soil and 264 q/ha on light soil. A response of 2.9 and 2.1 q/ha of green fodder per kg N/ha was obtained when nitrogen level was increased from 30 to 60 and from 60 to 90 kg N/ha, respectively on medium heavy soil. On light soil a response of 2.4 and 1.0 q/ha green fodder per kg N/ha was obtained for corresponding increases in the nitrogen levels.

Seed yield

The seed yields of 19.4, 20.5 and 22.8 q/ha obtained with irrigation at 25 per cent, 50 per cent and 75 per cent A. S. M., respectively on medium heavy soil were not significantly different. Nitrogen application at 60 kg N/ha resulted in increased seed yield of 5.7 q/ha over 16.3 q/ha obtained with 30 kg N/ha. Nitrogen at 90 kg N/ha did not significantly increase the seed yield over 60 kg N/ha.

On light soil also the seed yields of 11.0, 10.8 and 11.8 q/ha obtained with irrigation at 25 per cent, 50 per cent and 75 per cent A. S. M., respectively were not significantly different. Nitrogen application at 60 kg N/ha resulted in increased seed yield of 2.7 q/ha over 9.0 q/ha obtained with 30 kg N/ha. Highest level of nitrogen (90 kg N/ha) did not give significantly higher yield as compared to medium level (60 kg N/ha)

M.P. Chari, cowpea and guar sown pure and mixed

This was the second year of experiment after the treatments of crops and their mixture were modified last year. The crops were grown under optimum moisture regime (F.C. to 75 per cent A.S.M.).

Results revealed that the green fodder yield of pure sown M.P. Chari (734 q/ha) obtained in 4 cuts was significantly higher than the yield of pure sown cowpea (513 q/ha) and *guar* (410 q/ha) obtained in 4 cuts by sowing twice (in March and July) and taking 2 cuts from each sowing. The yield of M.P. Chari+cowpea (746 q/ha) and M. P. Chari+*guar* (711 q/ha) mixture was at par with the yield of pure sown M. P. Chari and was significantly more than the yield of pure sown cowpea and guar. The proportion of cowpea in M. P. Chari+cowpea mixture was 17 per cent by weight and that of guar in M.P. Chari—guar mixture was 10 per cent. Growing of M.P. Chari+legume mixture in alternate strips of two rows each gave an outturn of 758 q/ha which was superior to growing in alternate single rows which gave an outturn of 690 q/ha.

Cropping patterns for year round fodder production

Trial was continued for the third year. Rabi legumes were sown by the end of October in the intercrop space between napier. Four cuts of berseem, five cuts of berseem+lucerne and six cuts of lucerne were taken. Results showed that green fodder yields of 288, 386 and 428 q/ha obtained in case of rabi legumes with irrigation at 25 per cent, 50 per cent and 75 per cent A.S.M., respectively were significantly different. Yields of berseem (472 q/ha) and berseem+lucerne (425 q/ha) were significantly more than the yield of lucerne (206 q/ha).

The average total green fodder yield of napier in four cuts was 813 q/ha. The yields of napier under different cropping patterns were similar. It was noted that the yield of napier decreased considerably in the consecutive years. In the first year, the aggregate yield was 1642 q/ha, in the second year 1204 q/ha and in the third year it was only 813 q/ha. Irrigation application at 75 per cent A.S.M. gave the maximum yield (867 q/ha) followed by that under 50 per cent (801 q/ha) and 25 per cent (771 q/ha) A.S.M. treatments.

The intercropped cowpea gave an average yield of 16.2 q/ha. After berseem, two crops of cowpea were taken with a total yield of 37 q/ha. After lucerne and

berseem+lucerne mixture one cowpea crop was taken which gave an yield of 4.5 and 6.9 q/ha, respectively.

The aggregate yield analysis for 1971 revealed that frequent irrigation levels significantly increased total green fodder from 1066 q/ha for 25 per cent A.S.M. to 1211 q/ha for 50 per cent A.S.M. and 1313 q/ha for 75 per cent A.S.M. treatment. Highest green fodder yield of 1298 q/ha was obtained with berseem-napier-cowpea crop combination, followed by 1251 q/ha with berseem+lucerne—napier—cowpea and 1040 q/ha with lucerne—napier—cowpea combination.

Hybrid napier under varying plant density and nitrogen fertilization

This was the second year of the trial. The crop gave four cuts of green fodder giving an average yield of 915 q/ha. The yield of napier increased with the increase in moisture supply in the first cut since the differential irrigation treatment could be maintained. During the 2nd, 3rd and 4th cut the differential irrigation schedule could not be adhered to due to rainfall as a result of which the crop did not show any differential response. This was reflected in the aggregate yield.

Different plant densities, 27,777 to 55,555 hills/ha, did not result in differential yield. This finding was in conformity with the previous years results.

Nitrogen application significantly increased the yield. Application of 40 kg N/ha at each cut (160 kg N/ha total) gave an yield of 664 q/ha. Increase in nitrogen application from 40 to 80 kg N/ha at each cut (320 kg N/ha total) increased the yield by 1.97 q/ha per kg N applied and a further increase in nitrogen application to 120 kg N/ha at each cut (480 kg N/ha total) resulted in the increase of 1.44 q green fodder per kg N applied.

Soil-moisture stress on M. P. Chari

This was the first year of the experiment. Crop was sown on 20th March, 1971 and soil moisture stress was imposed by withholding irrigations at different stages of crop growth and the yields were compared with the control which was not subjected to stress at any stage and received optimum irrigation (F.C. to 75 per cent A.S.M.). The crop was cut for fodder on 2-6-1971 at 50 per cent flowering.

The results revealed that irrigation at optimum level (control) gave the maximum yield (306 q/ha) and stress at establishment (0-30 days after sowing), elongation (31-55 days) and primordia (56-75 days) stages reduced the green fodder yield by 5, 20 and 27 per cent, respectively. Stress during both elongation and primordia stage reduced the yield by 48 per cent. Irrigation at suboptimum level (F.C. to 50 per cent A.S.M.) during establishment stage and then at optimum level till 50 per cent flowering gave as much yield as that of control.

SA-6 : STUDIES TO IMPROVE SEED YIELD OF ESTABLISHED FODDER

(C. T. Abichandani, N. D. Mannikar, J. T. Karnani, A. S. Gill and S. N. Tripathi)

Micronutrients spray on berseem

The trial was repeated for the second year. Mn and Fe each at 1.0 kg/ha, Cu and Zn each at 0.5 kg/ha, Bo at 0.15 kg/ha and Mo at 0.10 kg/ha, and composite of all these micronutrients at concentrations mentioned were tried as a foliar spray 18 days after the third cutting.

Results showed that none of the treatments were statistically superior to the control (no spray). The seed yield varied from 647 to 724 kg/ha. The increases in seed yield due to Mn, Mo and composite were, however, 52, 57 and 38 kg/ha, respectively over the control yield of 672 kg/ha.

SA-7 : STUDIES ON THE FEASIBILITY AND ECONOMICS OF INTRODUCING FORAGE CROPS IN CROPPING PATTERN.

(M.N. Mishra, J. T. Karnani and Gopi Chandra)

Combination of perennial and annual fodders for year round fodder production

This was the second year of the trial. Three relay cropping patterns (M. P. Chari—berseem, Sudan grass—berseem and teosinte—berseem) were compared with three overlapping cropping patterns (berseem+Japan sarson+napier+cowpea, berseem+Japan sarson+lucerne+napier+cowpea and lucerne+napier+cowpea). Total green fodder yield obtained from October 1970 to September 1971 showed that overlapping cropping pattern with berseem+Japan sarson and napier followed by sowing of cowpea in inter-row spaces gave significantly higher green fodder yield of 1822 q/ha than rest of the systems. This was followed by berseem—Sudan grass (1698 q/ha) and berssem+Japan sarson+lucerne and napier interplanted with cowpea (1674 q/ha).

Cropping pattern for maximum fodder production per unit area per unit time

Six intensive cropping patterns were compared. Total green fodder harvested during the first year from December, 1970 to November, 1971 showed that the overlapping cropping system of berseem+Japan sarson interplanted with hybrid napier in spring and growing of cowpea in the inter-row spaces gave the highest green fodder yield of 2863 q/ha. This works out to a production of more than 7.8 q/ha/day of green fodder. This was followed by berseem+Japan sarson+maize—cowpea—M. P. Chari+cowpea (1972 q/ha), oat—M. P. Chari—turnip 1923 q/ha and berseem—Japan sarson—M. P. Chari+cowpea (1842 q/ha).

SA-8 : MAXIMUM PRODUCTION POTENTIAL TRIAL

(M. N. Mishra, S. N. Tripathi and Gopi Chandra)

Berseem+Japan *sarson*—M.P. Chari rotation was followed in the plot. The crop of berseem was sown on 3rd November, 1970. Nitrogen at the rate of 20 kg N/ha and phosphate at the rate of 80 kg P₂O₅/ha was given as a basal dose. Total of five cuttings were taken by first week of June 1971 after which M. P. Chari was sown on 10th June 1971 and applied with 50 kg N/ha and 40 kg P₂O₅/ha basal followed by 30 kg N/ha top dressing after 30 days of sowing and after first cutting. Total two cuttings were taken in M. P. Chari. The yield data are given below :

| <i>Crop</i> | <i>Green fodder yield (q/ha)</i> | <i>Dry matter yield (q/ha)</i> |
|---|----------------------------------|--------------------------------|
| 1. Berseem+Japan <i>sarson</i> (5 cuttings) | 709.2 | 91.5 |
| 2. M. P. Chari (2 cuttings) | 749.7 | 211.6 |
| Total | 1,458.9 | 303.1 |

The low yields of berseem+Japan *sarson* are due to severe attack of root-rot disease.

Research Contemplated

1. Effect of soil moisture stress at different stages of growth on seed yield of (a) berseem and (b) oat.
2. Comparative studies of check basin, short furrow and ditch irrigation methods in lucerne.
3. Effect of varying duration of flooding on the performance of (a) graminaceous and (b) leguminous fodder crops grown during *kharif* season.
4. Influence of micronutrients on fodder production of M. P. Chari under rainfed conditions.
5. Soil test and response studies in fodder crops.
6. Phosphate status of soils of natural grasslands and other forage growing areas.
7. Effect of ascorbic acid on seed production of berseem.
8. Introducing fodder catch crops in grain rotations.
9. Effect of growth retardants on seed yield of oats.
10. Agronomical trials on *Pennisetum pedicellatum*.

GRASSLAND MANAGEMENT DIVISION

Salient Features

Linear response to the application of nitrogen upto 90 kg N/ha was observed in natural *Heteropogon* grasslands and cultivated *Cenchrus ciliaris* and *C. setigerus* pastures with the highest dry-matter production of 48, 99 and 79 q/ha, respectively.

Cenchrus setigerus gave higher carrying capacity (10.5 sheep/ha/year) followed by *C. ciliaris* (7.0 sheep/ha/year), *H. contortus* (7.0 sheep/ha/year), *D. annulatum* (6.2 sheep/ha/year) as compared to that of *Chrysopogon fulvus* c. v. Chandigarh (4.1 sheep/ha/year). Deferred and rotational system of grazing provided 2925 animal grazing days as against 2097 obtained under continuous grazing system in *Sehima-Heteropogon* grasslands.

Sixty days cutting regime and 15 cm clipping height gave highest dry-matter production in *Sehima nervosum*, *Cenchrus ciliaris* and *C. setigerus*. Burning promoted the stand of *Heteropogon contortus* but adversely affected that of *Sehima nervosum*.

Primary production studies on the pattern of IBP on *Sehima-Heteropogon* grasslands revealed that during the growing period, rate of production was of the order of 8.2 g/m²/day with a peak aboveground standing crop of 1408 g/m² obtained in October. The highest underground production (467 g/m²) was obtained in June and the lowest in September (140 g/m²). It again showed considerable recovery at the end of the growing season in October (333 g/m²).

RESEARCH WORK DONE

GM-I MANURING OF GRASSLANDS

(K. A. Shankarnarayan, P. M. Dabadghao, Ravi Kumar and P. Rai)

The effect of various levels of N and P was studied in different grasses. In the case of *Heteropogon*, three levels of nitrogen (30, 60 and 90 kg/ha) and three levels of phosphorus (30, 60 and 90 kg P₂O₅/ha) and in the case of *Cenchrus ciliaris* four levels of nitrogen (0, 30, 60 and 90 kg/ha) and three levels of phosphorus (0, 30 and 60 kg P₂O₅/ha) were used. The above experiments were conducted for the second year in the former and for the third year in the latter. The results obtained indicated linear response to the application of nitrogen upto 90 kg/ha in natural *Heteropogon* grasslands and also in cultivated *C. ciliaris* and *C. setigerus* with the highest dry-matter production of 48, 99 and 79 q/ha, respectively. There was, however, no response to the application of phosphorus either alone or in combination with nitrogen.

In the case of *C. setigerus*, the response to the application of nitrogen was similar to that of *C. ciliaris* described above. The highest dry-matter production (79.4 q/ha) was obtained with the application of 90 kg N/ha as compared to 38.8 q/ha obtained without the application of nitrogen.

Unlike in *C. ciliaris*, response to the application of phosphorus was significant in *C. setigerus* upto 60 kg P₂O₅/ha. The highest dry-matter production (69.4 q/ha) was obtained with the application of 60 kg P₂O₅/ha. As in *C. ciliaris* the interaction between N and P was not significant in *C. setigerus*.

GM-4 GRAZING MANAGEMENT

Relative grazing values of principal species of Sehima-Dichanthium cover

(V. S. Upadhyay, P. M. Dabadghao and K. A. Shankarnarayan)

The experiment was continued for the third year. Grazing by sheep commenced on 1st July in the paddocks of *Dichanthium annulatum*, *Chrysopogon fulvus* cv. Chandigarh, *Heteropogon contortus*, *Cenchrus ciliaris* and *C. setigerus*. Fixed stocking rate technique was practised by adjusting the grazing period with forage availability. Thus, sheep were withdrawn from the paddocks of *D. annulatum* and *C. fulvus*, cv. Chandigarh on 15th October and on 15th November from the paddocks of remaining 3 species.

Results showed that *C. setigerus* gave highest carrying capacity (10.5 sheep/ha/year) followed by *C. ciliaris* (7.0 sheep/ha/year), *Heteropogon contortus* (7.0 sheep/ha/year), *D. annulatum* (6.2 sheep/ha/year) as compared to *C. fulvus*, cv. Chandigarh (4.1 sheep/ha/year).

Continuous versus deferred-rotational grazing system

(V. S. Upadhyay, P. M. Dabadghao and K. A. Shankarnarayan)

The experiment was continued for the third year. Grazing commenced on 15th July with 18 heifers under both continuous and deferred-rotational grazing paddocks till 31st August. The stocking rate was halved to cope up with the reduced growth and production during the period from 1st September to 30th November. However, additional heifers were allowed to graze for the utilization of the extra quantity of forage available in the deferred compartments.

The fortnightly record of the animal body-weight-gain showed an average increase of 191 g/heifer/day under both the systems of grazing but the deferred-rotational system showed a distinct advantage in total animal grazing days (2925) over the continuous one (2097).

Effect of intensity and interval of cutting-cum-manuring on *Sehima nervosum*, *Cenchrus ciliaris* and *C. setigerus*

(P. M. Dabadghao, V. S. Upadhyay and K. A. Shankarnarayan)

The experiment was repeated separately for *Sehima nervosum*, *Cenchrus ciliaris* and *C. setigerus* for the second year with the treatments consisting of all combinations of 4 intervals of cutting (10, 20, 30 and 60 days), 3 intensities of cutting (5, 10 and 15 cm height) and 3 levels of nitrogen (0, 30 and 60 kg N/ha).

Results showed that the interval of cutting had a significant effect on dry-matter production in all the three species. Sixty days of cutting regime gave highest dry-matter yield of 49.4, 20.0 and 29.8 q/ha in the respective three species.

The intensity of cutting showed a differential response, its being significant only in case of *S. nervosum* and *C. setigerus*. Clipping height of 15 cm was most effective in terms of total yield.

Manurial application was significant only in the two *Cenchrus* species. There was, however, no advantage of increasing the nitrogen level from 30 to 60 kg N/ha.

GM-6 STUDY OF PLANT SUCCESSION IN GRASSLANDS

Sehima-Dichanthium grass cover

(B. K. Trivedi, Vinod Shankar, K. C. Kanodia and P. M. Dabadghao)

Observations for the fourth year on the ten list quadrats, two denuded quadrats and five selected crevices revealed the following trends in plant succession.

The substratum first gets colonised with liverworts and mosses rendering it favourable for the invasion of species higher in succession. This was followed by *Aristida* stage with associated species such as *Panicum* sp., *Sporobolus* sp., *Brachiaria* sp., *Urochloa* sp., *Indigofera cordifolia* and *Borreria stricta*. The trend appeared progressive with the appearance of *Digitaria* sp., *Dactyloctenium* sp., *Setaria* sp., *Sporobolus* sp., *Borreria stricta*, *Euphorbia hirta*, *Eragrostis* sp., and *Cassia pumila*. *Eragrostiella bifaria* apparently constituted the next important stage which marked the appearance of perennial species consequent upon formation of soil. This was succeeded by *Heteropogon contortus* stage marked by the presence of both perennial and annual forms. Observation on the denuded quadrats supported the successional trends observed in the list quadrats. Studies on the rock crevices showed that *Chrysopogon fulvus* was dominant and *Tephrosia villosa* was associated with it.

Effect of burning on the botanical composition in *Sehima* grassland.

(B. K. Trivedi, Vinod Shanker, K. C. Kanodia and P. M. Dabadghao)

The experiment was continued for the fourth year. The treatments consisted of burning every year, once in 2 years, and once in 3 years with or without grazing.

The burning treatment was imposed in the third week of January. Observations on the botanical composition, vigour and yield were recorded.

Vigour and yield were not affected by the burning treatments with or without grazing. Observations on the botanical composition indicated that (i) grazing alone was beneficial in promoting cover and density of *Sehima nervosum* but appeared to be detrimental to the stands of *Heteropogon contortus* and (ii) in contrast to the above, burning alone promoted the stands of *H. contortus* but decreased that of *S. nervosum*.

GM-7 SURVEY OF GRASSLAND

Bundelkhand Region-Jhansi district.

(K. C. Kanodia, S. Pandey and B. K. Trivedi)

Mauranipur Tehsil :

Information on the village grazing lands of Mauranipur Tehsil of Jhansi District were collected. On the basis of the animal units *vis-a-vis* availability of grazing lands, the grazing intensity was worked out for all the villages (total 174) of the Tehsil. Twenty villages were selected at random for the condition survey of grazing lands representing 5 grazing intensities : no grazing, light grazing, moderate grazing, heavy grazing and very heavy grazing.

Jhansi Tehsil :

On the basis of the survey data collected for Jhansi Tehsil thematic maps on geomorphology, soil and condition classes of grasslands have been prepared on 1" = 4 miles scale.

Grassland herbarium

(K. C. Kanodia and B. K. Trivedi)

One hundred fifty eight species were added to the Herbarium bringing the total to 3001 specimens, 801 species, 355 genera and 61 families.

GM-8 AUTECOLOGY OF GRASSLAND SPECIES

(P. S. Pathak, R. Debroy and P. Rai)

Germination studies on grasses :

Maximum germination was obtained after storage for 21 months in *Dichanthium annulatum*, 17 months in *Chrysopogon fulvus*, 14 months in *Themeda quadrivalvis*, 10 months in *Bothriochloa pertusa*, 9 months in *Heteropogon contortus*, and 8 months in *Sehima nervosum* and *Melanocenchris jacquemontii*.

Seeds of *D. annulatum*, *M. jacquemontii*, *C. fulvus*, *Oropetium thomaeum* and *Digitaria aegyptiaca* showed the presence of water soluble inhibitors.

When seed germination was tested at the alternating temperature 32°C \rightleftharpoons 16°C, it was observed that germination increased in *D. annulatum* 8 hours 16 hours
C. ciliaris, *C. setigerus*, *S. nervosum*, *C. fulvus*, *B. pertusa*, *H. contortus*, *O. thomaeum*, *D. aegyptiaca*, and *Eragrostiella bifaria*. This temperature, however, proved unfavourable to *C. fulvus*, cv. Chandigarh, *M. jacquemontii* and *Pennisetum pedicellatum*.

Pre-treatment with thiourea and potassium nitrate promoted the seed germination in *M. jacquemontii*, *C. fulvus* and *S. nervosum*.

Application of Gibberelic acid and Ascorbic acid generally promoted the germination of *D. annulatum* seeds.

Germination studies on fodder trees

Germination studies on *Leucaena glauca* revealed the following : (i) Freshly collected seeds do not possess embryo dormancy but testa dormancy is present. (ii) There is gradual loss of viability due to storage and at the end of 2 years, only 25 per cent germination was recorded. (iii) Alternating temperature 32°C \rightleftharpoons 20°C 8 hours 16 hours gave maximum germination (81 per cent). Similar results were obtained by keeping soaked seeds at 65°C for 3 hours. (iv) Seed-coat, which does not allow successful emergence, can be safely softened through scarification by conc. H₂SO₄ for 10 minutes. (v) Scarified seeds gave the best results when sown at 4 cm depth.

GM-9 EVALUATION OF FOREST GRAZING RESOURCES OF DRY DECIDUOUS FOREST GRASSLANDS.

(R. Debroy and P. S. Pathak)

Studies were carried out in three forest ranges viz., Talbehat, Jhansi and Gursarai of the Bundelkhand Forest Division. Observations were recorded on vegetation cover, forage production, canopy cover, botanical composition and vigour of the perennial grasses. Highest forage production of 1728 kg/ha was observed in Kachir coupe II of Gursarai Range. This was followed by 694 kg/ha in Vashney coupe II, 655 kg/ha in Harashpur coupe II and 555 kg/ha in Sukhwah coupe III in Gursarai, Talbehat and Jhansi ranges, respectively. Lowest forage production 219 kg/ha was recorded in Hassar coupe II of Talbehat Range.

GM-10 PRIMARY PRODUCTIVITY, ENERGETICS AND NUTRIENT CYCLING IN SEHIMA-HETEROPOGON GRASSLAND.

(Vinod Shankar, K. A. Shankarnarayan and P. Rai)

Seasonal variation in the composition, standing crop and net production was studied during the one-year cycle (July, 1970 to June, 1971). With the onset of the

monsoon in the late June the growth of the grass species was initiated marking the beginning of the upward trend in the above ground standing biomass until it reached the peak in October (1408 g/m²). Thereafter, there was, hardly any fresh growth until February. March-April registered the spring growth (1187 g/m²). During May the lowest aboveground biomass (496 g/m²) was recorded but the litter production was the highest (226 g/m²) of the year.

Underground dry-matter production also exhibited marked seasonal trends. The highest value recorded was for the month of June (467 g/m²) and the lowest for the month of September (140 g/m²). It again showed considerable increase in October (333 g/m²).

Seasonal and annual net production appeared very high for *Sehima-Heteropogon* grassland with the aboveground production of 987 and 1010 g/m² and the rate of production of 8.2 and 2.8 g/m²/day respectively.

GM-11 SILVIPASTORAL STUDIES

(R. Debroy and P. S. Pathak)

Studies on the establishment and growth of fodder trees alongwith grasses to find out a suitable tree-grass combination for optimum production and carrying capacity were undertaken. The treatments were combination of (i) two fodder trees, (ii) two fodder tree spacings (iii) three grass stands. About one year old seedlings of fodder trees were planted in lines during July as per spacing treatments. Seeds of grasses were sown in lines 45 cm apart in the intervening spaces during August. The establishment of sown grass was patchy due to heavy rains. However, *Cenchrus ciliaris* showed better establishment compared to *C. setigerus*. *Acacia tortilis* recorded almost cent per cent (99 per cent) survival compared to 85 per cent in *Lucaena glauca*.

Silvicultural studies

In order to study the various silvicultural characteristics of fodder trees 22 species were planted in the arboretum during the monsoon. Out of these fifteen species viz. *Albizzia amara*, *Acacia tortilis*, *Acacia arabica*, *Bauhinea alba*, *Bauhinea variegata*, *Prosopis cineraria*, *Azadirachta indica*, *Cassia phyllodenia*, *Zizyphus spinacristae*, *Leucaena glauca*, *Dalbergia sissoo*, *Albizzia lebbek*, *Acacia auriculiformis* and *Sesbania grandiflora* exhibited 80-100 per cent survival, five species viz., *Hardwickia binata*, *Acacia ligulata*, *Sesbania aegyptiaca*, *S. microcarpa* and *Colophospermum mopanae* showed 60-80 per cent survival and two species viz., *Cassia alata* and *Morus alba* recorded below 50 per cent survival. During a period of three and a half month *Albizzia amara* recorded highest height increment of 42.6 cm followed by 40.5, 28.2, and 21.4 cm in *Acacia arabica*, *A. tortilis* and *Zizyphus spinacristae*, respectively. Least height increment of 29 cm was observed in *Prosopis cineraria*.

RESEARCH CONTEMPLATED

1. Effect of the application of varying doses of phosphate and of varying intervals of cutting on growth and forage production of tropical pasture legumes.
2. Studies on comparative merits of natural grasslands subjected to improved management practices and cultivated pastures for animal production.
3. Evaluation of site potentialities in *Sehima-Dichanthium* Cover.
4. Study of moisture regime in grassland soils and its effect on growth and dry-matter production of grasses.
5. Effect of phosphate on root growth of principal grasses of *Sehima-Dichanthium* cover.

WEED ECOLOGY AND CONTROL DIVISION

Salient Features

Picloram and atrazine were effective in controlling weeds in *Heteropogon* grasslands and their application could be combined with that of nitrogen for enhanced yields. Atrazine was also effective in *Dichanthium* and *Iseilema* grasslands when applied during reseeding.

Pre-emergence treatment of either prometryne or alachlor controlled the weeds and thereby increased the yields of okra capsules and the produce was harmless for animal consumption.

Selective killing of weeds of Jute crop was achieved through the application of benz-meth carbamate at the rate 3 kg/ha or EPTC 2 kg/ha. Pre-emergence application of the benz-meth carbamate or molinate at the rate of 4 to 6 kg/ha was effective for weed control in broadcast upland paddy.

Four pre-emergence and 3 post-emergence herbicides were located for controlling the noxious weed *Parthenium hysterophorus* L.

RESEARCH WORK DONE

WE-1 : CONTROL OF WEEDS OF GRASSLAND

(R. K. Pandey and R. P. Singh)

Heteropogon contortus

The trial was repeated for the second year. Picloram (pellets) at 15 and 30 kg/ha, 2, 4-D and atrazine at 1 kg a. i./ha (post-emergence) and combinations of picloram at 15 kg/ha with 2, 4-D or atrazine at 1 kg a. i./ha alongwith a control (no treatment) were tried in combination with nitrogen at 2 levels (0 and 50 kg N/ha).

Broadcasting picloram pellets during the monsoon effectively cleared all brushes with the exception of under shrubs. Treatments of picloram, 2, 4-D and atrazine were effective on broad-leaved weeds.

The dry-matter yield was the highest i. e. 86 q/ha in the picloram (30 kg/ha) treated plots followed by 82 q/ha with picloram (15 kg/ha) and 67 q/ha with atrazine as against 62 q/ha in control (untreated) plots. Nitrogen application at the rate of 50 kg N/ha significantly increased the dry-matter yield of grassland from 62 to 75 q/ha.

Dichanthium annulatum and *Iseilema laxum*

Yield was recorded from *Dichanthium annulatum* and *Iseilema laxum* grasslands treated last year with the following herbicide combinations : A. Pre-planting

treatments consisting of (i) soil incorporation of trifluralin at the rate of 1.5 kg a. i./ha, EPTC at the rate of 4 kg a. i./ha and their combination, (ii) soil application of atrazine at the rate of 1.5 kg a. i./ha, (iii) foliar application of DSMA at the rate of 3 kg a. i./ha along with a control (no treatment) and B. Post-planting treatments of 2, 4-D amine at the rate of 1 kg a. i./ha along with a control (no treatment).

The application of atrazine was the best which increased dry-matter yields to 131 and 144 q/ha as compared to the yields 59 and 46 q/ha obtained from the control plots of *Iseilema* and *Dichanthium*, respectively. Post-emergence application of 2, 4-D increased yields. However, this was not significant.

WE-3 : CONTROL OF ANNUAL WEEDS OF RABI SEASON

(R. P. Singh and R. K. Pandey)

Wheat and mustard

In this trial four herbicides viz., propachlor, sesone, linuron and chlorobromuron were tried at two levels along with the control (no treatment) and handweeding treatment. Pre-emergence treatment of linuron at the rate of 1 kg a. i./ha effectively controlled weeds leading to increased yields of wheat by 4.7 and mustard by 0.6 q/ha over the control (no treatment) yields of 26.3 q/ha of wheat and 3.1 q/ha of mustard. The hand weeding was *at par* with this treatment for the wheat yields. For mustard, the highest yield of 4.1 q/ha was obtained with propachlor at 1.0 kg a. i./ha.

Spinach and Coriander

Propachlor, trifluralin and amiben each at two levels were compared with hand weeding and control (no treatment) for the trial with spinach whereas in coriander propachlor was replaced by prometryne.

Propachlor application at 6 kg a. i./ha gave the highest yield of 311 q/ha (2 cuttings) of spinach as compared to 182 and 242 q/ha yield obtained in control and hand-weeded plots, respectively. Trifluralin was found to be harmful to spinach.

For the coriander, prometryne application at 1.0 kg a. i./ha resulted in the highest total yield 290 q/ha in two cuttings. The yields obtained with control and hand weeding treatments were 47 and 130 q/ha, respectively.

WE-4 : CONTROL OF ANNUAL WEEDS OF KHARIF SEASON

(R. K. Pandey and R. P. Singh)

Black gram and green gram

Pre-emergence application of nitrofen (1.5 and 3.0), linuron (0.5 and 1.0), alachlor 1.5 and 3.0) and Monsante 099 (0.5 and 1.0 kg a. i./ha) was compared with the local method of weeding and control (no treatment).

Annual weeds offered little competition. Alachlor (both doses), Monsante 099 (both doses) and lower doses of linuron and nitrofen herbicides were selective for black gram var. T. 65. The green gram var. T₁ tolerated alachlor and Monsante 099.

There was no significant increase in the yields of both the crops. In general, the yield of green gram was poor because of heavy and continuous rain during flowering.

Soyabean

Pre-emergence treatments of chlorobromuron (0.75 and 1.50), nitralin (1.0 and 2.0), alachlor (1.5 and 3.0) and Monsante 099 (0.5 and 1.0 kg a. i./ha) were tried alongwith hand weeding and control in soyabean var. Bragg.

The best weed control was achieved with nitralin. The treatment of nitralin at either doses resulted in a significant increase in yield over no treatment. The yields obtained were 11.7, 9.1, 4.2 and 3.2 q/ha with nitralin at the rate of 2 kg a. i./ha nitralin at 1.0 kg a. i./ha, hand weeding and no treatment, respectively. A demonstration of chemical weed control method in this crop was given to the soyabean agro-industry at Nagpur.

Bhindi (*Abelmoschus esculentus*)

Pre-emergence treatments of prometryne (1.0 and 2.0), alachlor (2.5 and 4.0), amiben (1.5 and 3.0 kg a. i./ha) and pre-planting application of pebulate (2.0 and 4.0 kg a. i./ha) were included in this trial alongwith hand weeding and no treatment.

Prometryne, alachlor and amiben herbicides were found very effective in controlling weeds except sedges. Pebulate suppressed the sedge population in the early stages of crop growth. All herbicide treatments except pebulate resulted in a significant increase in the green capsule yield of the crop over no treatment. Yield differences between the doses of atrazine and alachlor were not significant.

The capsule yields of 206 and 170 q/ha were obtained in the treatments of alachlor at 4.0 kg a. i./ha and prometryne at 2.0 kg a. i./ha, respectively. The capsule yields of control (no treatment) was 39 q/ha and that in the hand weeding 90 q/ha.

Jute

Exploratory weed control trial was conducted in jute var. JRO 632 with pre-planting treatment of EPTC (1.5 and 3.0) and benz-meth carbamate (3.0 and 6.0), pre-emergence application of benz-meth carbamate (3.0 and 6.0) and post-emergence application of dalapon (2.0 and 4.0) and MSMA (0.75 and 1.50 kg a. i./ha). The hand weeding and no weeding were also included as controls.

Benz-meth carbamate gave almost complete weed control while EPTC was less effective for broad-leaved weeds. Pre-emergence application of benz-meth carbamate severely damaged seedlings of jute. Lower doses of benz-meth carbamate, dalapon and MSMB appeared to be promising.

Residual effects

The residual effects of herbicidal application to the *kharif* season crops, on the subsequent *rabi* season crop were studied.

Atrazine and 2, 4-D amine used for controlling weeds in fodder *Sorghum* (M. P. Chari) appeared to be non-hazardous to oat on red-gravelly soils.

EPTC, trifluralin, amiben and chlorobromuron used for weed control in cowpea were found to be safe for oats (fodder) in red gravelly soil and wheat in sandy loam soils.

WE-6 : EVALUATION OF HERBICIDES

(T. R. Dutta, J. N. Gupta, R. K. Gupta, R. K. Pandey and J. Prasad)

Rabi crops

Trials for preliminary screening of herbicides in wheat, barley, oat, gram, linseed and mustard were conducted with six herbicides at 3 levels. Among these, dichloroprop and mecoprop were found to be safe at all the doses for all the crops. Buturon was unsuitable for oat but was potentially suitable for other crops.

Jute

Seven pre-emergence herbicides were screened for weed control and crop safety in jute var. JRC 212 and JRO 632. Among these, benz-meth carbamate and EPTC upto 2 kg a. i./ha were found to be superior. Among post-emergence herbicides screened, the crop was sensitive to dalapon which is currently used for weed control in jute. MSMA and DSMA also caused crop injury while the crop was susceptible to propanil.

Rice

Among the ten herbicides evaluated for rice crop, molinate (pre-planting at 2.0 and 4.0) and benz-meth carbamate (pre-emergence at 4 and 6.0 kg a. i./ha) were found effective for weed control without injury to the crop.

Vegetable crops

Pre-emergence and pre-planting herbicides at different doses were screened for weed control in the nursery raised for tomato, brinjal and chillies.

Nitrofen, amiben, pebulate and propachlor were found selective for these seedlings. Seedlings of tomato and brinjal also tolerated trifluralin, prometryne and machete (2-chlore-2-6' diethyl) n (butoxyethyl)-acetanilide) herbicides.

Parthenium hysterophorus L.

Out of 21 herbicides evaluated on *Parthenium hysterophorus* L. each at two concentrations, the following treatments gave good kill of this weed.

- (i) Pre-emergence application of atrazine (1.0 kg a. i./ha), simazine (1.0 kg a. i./ha), manuron (0.75 kg a. i./ha) and chlorobromuron (1.0 kg a. i./ha).
- (ii) Post-emergence application of prometryne (1.0 kg a. i./ha), 2, 4-D amine (2.0 kg a. i./ha), DSMA 2.0 kg a. i./ha).

Synthesis of analogues

The following seven herbicide analogues were synthesised for their evaluation :

N-1, 2', 5'—dichlorophenyl phthamic acid, 2', 3, 4, 5, 5', 6-hexachlorophenyl phthamic acid, 2', 5', 2, 4-tetrachlore-phenoxy propionanilide, 2-methyl, 2', 4, 5' trichlorophenoxy acetanilide, 2', 4, 5'—trichlore-2-methylphenoxy propionanilide, 2, 2', 5'—trichloropropionanilide and 2, 2', 4, 5'—tetrachlorophenoxy acetanilide.

WE-7 : SURVEY AND COLLECTION OF THE WEEDS FROM DIFFERENT AGROCLIMATIC REGIONS OF THE COUNTRY

(S. R. Gupta, J. N. Gupta and T. R. Dutta)

A general survey of weeds in cultivated fields and grasslands was made and seeds of various weeds were collected. Germination of seeds of five important weeds viz., *Echinochloa colonum*, *Commelina benghalensis*, *Digitaria adscendens*, *Borreria stricta* and *Dactyloctenium aegyptium* was studied at monthly intervals at room temperature. The germination was lowest during November-February, and increased with rise in temperature from March onwards reaching a maximum in July. There was no significant difference in percentage germination of these seeds between July to October. The seeds collected in 1970, however, showed decline in percentage germination with storage period.

WE-9 : PRODUCE QUALITY AND PHYTOTOXICITY AS AFFECTED BY HERBICIDE APPLICATION

(R. K. Gupta, A. K. Srivastava, O.P.S. Panwar and T. R. Dutta)

Toxicity

A trial was conducted on rabbits to evaluate the produce toxicity of prometryne, alachlor, linuron and nitrofen herbicides applied for weed control in bhindi (*A. esculentus*) crop. The animals were divided into five groups each consisting of six animals. The green capsules were fed to the first four groups of animals and the fifth group was fed the produce from control plot (no treatment). The effects on various physiological parameters like changes in body-weight, effect on skin and fur, discharge from eyes and nose and other general conditions were observed.

The animals fed with herbicide treated produce maintained normal health and no adverse effect was noticed.

Chemical composition

The green capsules of *bhindi* obtained from the prometryne treated and control (no treatment) plots were analysed for N, P, Ca, ash, carbohydrate, crude protein, crude fibre and carotene content. Carotene, calcium and phosphorus content of the produce from control plot was slightly higher. Crude fibre content was higher in samples from herbicide treated plots. There were no significant changes in the level of other constituents.

Analytical methods for determining total carbohydrate, protein, vitamin C and carotene content have been standardized. Paper chromatographic techniques for isolation and identification of individual sugars have been worked out for the determination of qualitative changes in carbohydrate composition as affected by herbicide application.

RESEARCH CONTEMPLATED

1. Pre-release trials of new and improved weed control measures in various crops.
2. Studies on weed competition, migration and autecology,
3. Studies on poisonous weeds.
4. Studies on mobility, degradation and selectivity of herbicides.
5. Investigations on herbicide compatibility with pesticides, fertilizers, regulants, and adjuvants.
6. Trials for advance evaluation of herbicides in forage-based crop rotations, oilseeds, cotton, paddy, dryland farming and small holdings etc.
7. Intensive studies on effects of herbicide use on produce quality and animal toxicity.

PLANT ANIMAL RELATIONSHIP DIVISION

Salient Features

The digestibility coefficient of crude protein of first cut at pre-flowering stage of hybrid *jowar* (Swarna) was 66.2 while that of M.P. Chari was only 48.6. The corresponding per cent D.C.P. content was 5.66 and 2.62.

The varieties 272, Syn-1 and Syn-4 of lucerne were found promising on the basis of their crude protein (C.D.) yields. The application of K₂O upto 80 kg/ha continued to increase the C.P. yields of lucerne, but response to phosphorus application in this crop was observed upto 120 kg P₂ O₅/ha only.

The promising oat varieties on the basis of crude protein yields were 2681, 2636 and Alg (H₁₀) for single-cut and Brunner-10 and Kent for multi-cut (2 cuts). There was gradual decrease in the crude protein content from the first to the 2nd cut in oat and first to 5th cut in berseem.

Rumen metabolism studies with napier hay revealed that this fodder is slowly digested in the rumen.

RESEARCH WORK DONE

PAR-2 : STUDIES ON THE NUTRITIVE VALUE OF IMPORTANT FORAGE CROPS

(R. Mukherjee, N. C. Verma and A. P. Singh)

M.P. Chari and hybrid *jowar* (Swarna)

A digestibility trial was conducted in September using six adult Barbari bucks. M. P. Chari and hybrid *jowar* (Swarna) both of first cut at pre-flowering stage were the test fodders. Five grams each of common salt and supermind if mineral mixture were offered to each goat daily, but no concentrate mixture was fed. A preliminary feeding period of 10 days was followed by a collection period of 7 days. Hard stem, particularly of M.P. Chari was not consumed by the animals hence the lower portion (about 30 cm) was discarded and only remaining fodder was offered to the animals.

The average digestibility coefficients of dry-matter and organic matter of M. P. Chari and the hybrid *jowar* were found to be almost the same. But the digestibility coefficient of crude protein of hybrid *jowar* was 66.2 while that of M. P. Chari was only 48.6.

The D. C. P. contents were found to be 2.62 and 5.66 per cent, while the contents of T. D. N. were 69.2 and 64.9 per cent in M. P. Chari and hybrid *jowar* (Swarna), respectively.

PAR-3 STUDIES ON THE NUTRIENT YIELD AND POSSIBLE TOXIC AND OTHER PHYSIOLOGICALLY ACTIVE CONSTITUENTS IN FORAGE CROPS

(A. P. Singh and S. C. Gupta)

These studies were undertaken on samples collected from experiments laid out by different Divisions. The results obtained are summarised below experiment-wise :

Berseem varieties :

Samples for chemical analysis were obtained from a trial with thirteen berseem varieties. The first cut was taken 60 days after sowing, while subsequent cuts were made at intervals of about 30 days. In all four cuts were taken. The percentage dry-matter content of the varieties varied from 10.8 to 12.6 in the first cut, 9.5 to 11.6 in the 2nd cut, 10.8 to 12.4 in the third cut and from 16.8 to 19.0 in the fourth cut. The corresponding percentage crude protein content varied from 19.9 to 24.3 in the first cut, 20.1 to 23.5 in the 2nd cut, 21.5 to 24.4 in the third cut and from 17.9 to 20.9 in the fourth cut. The percentage neutral detergent fibre varied from 31.3 to 36.6 in the first cut, 35.4 to 42.1 in the 2nd cut, 39.0 to 43.3 in the third cut and from 42.6 to 51.7 in the fourth cut.

Lucerne varieties :

From an initial evaluation trial with ten varieties of lucerne, samples were collected for chemical analysis. First cut was taken 80 days after sowing. Second and third cuts were taken 40 days after the 1st and 2nd cuts, respectively. On the basis of total crude protein yield (kg/ha) in three cuts, varieties numbered 272, Syn 1 and Syn 4 appeared to be the most promising with crude protein yields of 1240, 1210 and 1210 kg/ha. The variety Syn-6 gave the lowest yield of 830 kg/ha.

Oat varieties :

Samples from an initial evaluation trial with 25 varieties of oat, harvested at 50 per cent flowering were analysed for chemical composition. Most promising varieties were 2681, 2636 and Alg $\left(\frac{H}{10}\right)$ with 1140, 1070 and 1030 kg/ha yield of crude protein. The variety 3018 gave the lowest crude protein yield of 540 kg/ha.

Chemical analysis of samples of twelve varieties of oat (single-cut) from a final evaluation trial harvested at 50 per cent flowering was carried out. The variety 2660 gave the highest crude protein yield of 770 kg/ha followed by 2672, 5/104, W-11 and Bamboo 966 with 690, 680, 660, and 650 kg/ha crude protein yield. The NDF per cent was lowest (53.0) in 37/14 followed by Brunner-10 with 53.5 per cent NDF. The varieties 2672 and 2670 appeared to be promising with 690 and 610 kg/ha crude protein yield and 59.7 and 55.9 per cent NDF, respectively.

Two oat (multi-cut) varieties *viz.*, Brunker-10, and Kent from a final evaluation trial with twelve varieties were considered quite promising in respect of their crude protein yields which were 1280 and 1050 kg/ha, respectively.

Oat under nitrogen and phosphate fertilization :

From a trial laid out using three varieties of oat each at three levels of phosphate (0, 30 and 60 kg P_2O_5 /ha) and four levels of nitrogen (0, 40, 80 and 120 kg N/ha), samples for chemical analysis were obtained after 108 days of sowing.

With the increased levels of fertilization of phosphorus and nitrogen, the average crude protein yield increased. The average crude protein yield with phosphorus at 0, 30 and 60 kg P_2O_5 /ha was 392, 518 and 586 kg/ha and those with nitrogen at 0, 40, 80 and 120 kg/ha were 340, 449, 583 and 623 kg/ha, respectively. The response to nitrogen was higher when given in combination with phosphorus at 60 kg P_2O_5 /ha. However, with P_2O_5 at 60 kg/ha, there was no response to nitrogen application beyond 80 kg N/ha when an average crude protein yield of 706 kg/ha was obtained. The average crude protein yield of different varieties *viz.* E. C. 13044, E. C. 13594 and Kent were 531, 506 and 459 kg/ha, respectively.

Lucerne with phosphate and potash fertilization

Chemical analysis of samples of four cuts of lucerne, from an experiment with 6 levels of P (0, 40, 80, 120, 160 and 200 kg P_2O_5 /ha) and 3 levels of K (0, 40 and 80 K_2O /ha) was undertaken.

Application of phosphorus upto 120 kg/ha increased the average crude protein yield upto 1460 kg/ha. Increasing this dose, further, did not result in increased yield. Potash continued to respond and gave an average crude protein yield of 1220 kg/ha at 80 kg K_2O /ha. The interaction between phosphorus and potash was significant. The average crude protein yields obtained without phosphorus and without potash were 600 and 1060 kg/ha, respectively.

Berseem and oats in crop rotations for high fodder production

Chemical analysis of the plant samples from a trial with berseem and oats as *rabi* crops in different crop rotations revealed that the crude protein percentage decreased progressively and per cent neutral detergent fibre increased from the first to the last cut. In berseem, crude protein (per cent) decreased from 22.2 to 15.8 and neutral detergent fibre (per cent) increased from 33.2 to 42.9 from the 1st to the 5th cut, respectively. In the case of oat, crude protein (per cent) decreased from 11.9 to 8.4 and neutral detergent fibre (per cent) increased from 55.4 to 59.8 from 1st to the 2nd cut. The first cut of berseem was taken 60 days after sowing and subsequent cuts at 40 days interval. The cuts of oat crop were taken at 50 per cent flowering.

Sehima and Heteropogon grasses at different stages of growth

Samples at 15 days intervals of *Sehima*, harvested from 15th July, 1971 to 30th September, 1971 and *Heteropogon*, harvested from 15th August, 1971 to 15th October, 1971 were analysed for chemical composition.

In both the cases, regrowth samples were also taken on 15th October, 1971 in the plots cut upto 30th August, 1971. Results are summarised below :

In the first cut of *Sehima nervosum*, total dry-matter and crude protein yields progressively increased from 8.70 to 61.45 q/ha and 53.5 to 234 kg/ha, respectively as the stage of maturity (or date of cutting) advanced except at the last stage (i. e. on 30-9-1971) where it slightly decreased from that of 15-9-1971. Per cent of crude protein, acid insoluble ash and phosphorus progressively decreased from 6.15 to 3.25 per cent, 13.04 to 11.10 per cent and 0.17 to 0.06 per cent, respectively. Ash and calcium contents did not show any trend with maturity. Similar trend was observed in the case of regrowth samples.

Total dry-matter yield and crude protein yields of the first cut of *Heteropogon contortus* progressively increased from 13.9 to 48.4 q/ha, 78.7 to 168 kg/ha, respectively as the stage of maturity (date of cutting) advanced with the exception of 30-9-71 where crude protein yield decreased from that of 15-9-71. Almost equal dry-matter yields were obtained when the cut was taken on 15-9-71 and 30-9-71. Percentage of crude protein dropped from 3.9 (cutting on 15-9-71) to 3.2 per cent (cutting on 30-9-71). Due to this, total crude protein yield was lower on 30-9-71 than that of 15-9-71. Content of crude protein, total ash, acid insoluble ash and phosphorus decreased progressively from 5.60 to 3.20 per cent ; 13.14 to 8.75 per cent ; 10.2 to 6.2 per cent and 0.129 to 0.055 per cent, respectively. Calcium content remained more or less constant. There were no differences in the crude protein and phosphorus content of the regrowth samples.

PAR-4 STUDIES ON THE EFFECT OF FEEDING IMPORTANT FODDER AND FORAGE CROPS ON RUMEN METABOLISM AND EFFICIENCY OF MILK PRODUCTION.

(A. Rehib and A. K. Dabadghao)

Rumen metabolism studies were carried out on fistulated Murrah calf No. 5 on six dates with a gap of 3 days between consecutive experimental dates. Throughout the experimental period the animal was given water at 6 A. M. and offered 5 kg of chaffed napier hay at 8. A.M. to be consumed till 10 A.M. only. The animal was again given water and napier hay *ad libitum* after 6 P. M.

The rumen liquor sample was collected at 8 A. M. just before feeding and the subsequent samples were collected at intervals of two hours. The pH, total volatile fatty acids (TVFA), ammonia-nitrogen and total nitrogen of the rumen liquor were estimated.

The results showed that the pH of the rumen liquor remained constant at 6.6. The concentration of TVFA remained more or less constant around 12.2 meq/100 ml from the time of start of feeding till 6 hours after the feeding (4 P. M.) was stopped and then the concentration decreased by 1.1 meq/100 ml within a period of two hours. This indicates that the fodder material is slowly digested in the rumen. The concentration of ammonia gradually decreased from 9.0 to 7.6 mg N/100 ml liquor.

The total nitrogen concentration of the rumen liquor varied from 52.3 to 59.7 mg N/100 ml rumen liquor. However, these figures did not show any definite rumen trend.

RESEARCH CONTEMPLATED

1. Evaluation of oat (kent), M. P. Chari, *guar* and cowpea at different stages of growth/cut and under different conservation practices in terms of proximate chemical composition, *in vitro* dry matter/organic matter digestibility and *in vivo* estimation of DCP and TDN yield.
2. Effect of grazing on natural *Sehima-Heteropogon* grassland with different levels of concentrate feeding for economic meat production.
3. Studies on growth rate, sexual maturity and 1st lactation yield in Murrah × Nili cross heifers on forage based ration.
4. Economics of milk production in cross-bred cows on forage-based ration under different systems of farming.
5. Evaluation of berseem and *guar* hay-making in terms of nutrient losses, palatability and cost.
6. Studies on production of volatile fatty acid and rate of digestion in the rumen of buffalo-calves/goats and efficiency on energy utilization following supplementation of green berseem hay on grass-based ration.
7. Effect of feeding herbicide and allied chemically treated fodder on microbial population of the rumen.

AGRICULTURAL ENGINEERING SECTION

AE-1 DESIGN, DEVELOPMENT AND EVALUATION OF FORAGE SEED COLLECTOR AND HARVESTERS.

(Jai Singh)

Grass seed collector

The newly developed prototype (experimental design) of this machine has been tested under field conditions for its functional requirements *i. e.* collection of the ripened seed of different grass species of the standing grasslands. Field trials on *Sehima nervosum*, *Dichanthium annulatum*, *Heteropogon contortus*, *Cenchrus ciliaris* and *Cenchrus setigerus* have shown satisfactory results. It was observed during tests that different speeds of the revolving sweeping reel and different pressures are required for collection of ripened seeds of different species.

Tractor-drawn 'Irrigation Channel-cum-Bund Former'

A prototype of the tractor-drawn 'Irrigation Channel-cum-Bund Former' has been designed, developed and fabricated. This implement can make desired size of channels and bunds in a single operation without disturbing the level of the field and the sown seed. The implement has been tested and used extensively at the Institute's Research Farm as well as on farmer's fields around Jhansi. The field trials have shown a net saving of Rs. 18-24/ha in labour and increase in efficiency (in terms of time saved) by 50-60 per cent. The implement is simple in design and can be fabricated by a village artisan at an approximate cost of Rs. 300/-.

Mechanical chicory seed separator from berseem seed

An experimental model prototype for separation of the chicory seed from the berseem seed, based on the principle of the surface characteristics, has been designed and fabricated. Trials have shown that this mechanical device can clean the seed to the extent of 98 per cent purity. Design of a mechanically sound unit is in progress. The above work has been done in close co-operation with the Farm Superintendent.

Effect of mechanical harvesting on regeneration and production of multi-cut-fodder crops.

An experiment on effect of mechanical harvesting on regeneration and production of multi-cut-fodder crops was conducted on M. P. chari (*Sorghum bicolor*) during the Kharif season, 1971. Three methods of harvesting, namely harvesting by hand *i. e.* control, harvesting by tractor-drawn mower and harvesting by tractor-drawn forage harvester were tried.

Observations on first cutting showed that the yield was higher in the mechanically harvested plots as compared to that in manually harvested plots. The degree of trampling varied significantly under the different harvesting methods. The trampling in case of manual harvesting was only by man, in case of mower by tractor, where as in case of forage harvester it was by tractor, forage harvester and trailer.

Observations have shown that the number of tillers was of the increasing order in the plots harvested by manual method, mower and forage harvester, respectively.

Observations taken on height of tillers did not show any significant variation due to different harvesting treatments.

MISCELLANEOUS WORK

Construction :

Construction of 2 silo pits, farm shop, a field laboratory room, and an open well were completed. In addition to this, planning and estimation of about 700 R.C.C. pipe line along with a overhead tank were done. Repairs of irrigation channels, inverted syphons and other farm structure were also carried out.

Repair and maintenance of farm machines :

Maintenance, servicing and repairs of all the agricultural machines including pumping sets, sprinkler irrigation equipment, transport vehicles and some of the laboratory equipments were carried out regularly. Repairs of office and laboratory electrical installations and appliances were attended to.

RESEARCH CONTEMPLATED

1. Design, development and evaluation of forage harvesters.
2. Design, development and evaluation of crusher for hay-making.
3. Evaluation and efficiency of irrigation methods for forage crops.
4. Soil and moisture conservation in natural grasslands.

AGRICULTURAL ECONOMICS AND STATISTICS SECTION

AES-1 : STUDY ON YEAR-TO-YEAR COST OF CULTIVATION OF GENERAL CROPS (KHARIF AND RABI) IN THE CENTRAL RESEARCH FARM

(Ram Prakash and H. H. Datta)

Cost of cultivation of M.P. Chari (fodder), cowpea (seed), cowpea (fodder), teosinte (seed), oat (grain), berseem (seed-cum-fodder), gram and linseed crops for the year 1970-71 had been worked out.

It has been observed that cost of M.P. Chari fodder production at Rs. 2.00/q during the year 1970-71 was a little higher than its corresponding estimate of Rs 1.80/q during the year 1969-70. The higher cost can be attributed to use of higher level of inputs like seed, manual labour and tractor power. Cost of cultivation per hectare of M.P. Chari fodder crop was Rs. 384-34 during the current year, as against the corresponding cost of Rs. 287.55/ha during the preceding year.

Cost of cowpea seed production was estimated at Rs. 103.14/q this year, as against Rs. 242.36/q last year. Over 57 per cent reduction in its cost during the current year was due to rise in yield with less inputs per unit area. Similarly, cost of production per quintal of cowpea fodder at Rs. 3.20 during the current year, as against at Rs. 4.71 last year, registered 32 per cent reduction in its cost per unit of output. Per hectare cost of cultivation of this crop was, accordingly, Rs. 556.98 for seed this year, compared to the corresponding estimate of Rs. 573.29 during the previous year.

Costs of cultivation of oat for seed and of berseem for seed-cum-fodder were Rs. 548.28/ha and Rs. 432.65/ha, respectively during 1970 71, as against Rs. 426.20/ha and Rs. 751.64/ha, respectively last year. Accordingly, cost per quintal of oat seed was Rs. 51.30 during the current year, compared to Rs. 56.48 during 1969-70, thus, signifying over 9 per cent decrease in its cost on account of higher yield obtained with use of higher level of inputs like manual labour and tractor power. Cost of berseem seed production at 138.51/q remained more or less stable despite a significant drop in its cost per unit area which was offset by great loss in yield due to prolonged water-logging condition during this year, as compared to last year. Berseem fodder was also affected by this adverse phenomenon with the result that its cost rose as high as Rs. 1.13/q during the current year, as against only Rs. 0.68/q during the previous year.

Cost of grain production of gram crop was up by 87 per cent this year over Rs. 152.79/q of last year due to (i) more intensive use of inputs like fertilizer without proportionate response in yield and (ii) crop damage by wild animals.

Cost of cultivation of linseed crop was Rs. 410.17/q with its seed yield of 3.18 q/ha resulting in the seed cost at Rs. 120.72/q during 1970-71. Cost of teosinte seed production was estimated at Rs. 168.17/q on its cost of cultivation at Rs. 498.73/ha with a poor yield of 1.25 q/ha during the current year.

AES-3 : STUDIES ON THE ECONOMICS OF MILK PRODUCTION
(H. H. Datta, Ram Prakash and P. R. Sreenath)

Cost of milk production of eight "Murrah" buffaloes in the Central Research Farm was worked out from the data available for one year from July '70 to June '71.

It was estimated that daily average yield of milk per animal was 3.26 litres at a net production cost of Rs. 1.04 per litre during this period, compared to the corresponding estimate of 3.11 litres at the rate of Rs. 1.20 per litre for the previous year. This accounted for over 13 per cent reduction in the unit cost of milk production this year which was made possible for : (i) higher milk yield, (ii) economics obtained in the substitution of fodders for concentrates, and (iii) better care and maintenance of the herd as evident from the relatively lower cost in their upkeep. The average annual maintenance cost of a milch animal (including its calf) was worked out at Rs. 1,243.58 with an annual mean production of 1,191.36 litres during the year under report.

As regards the share of food cost in the overall cost of milk production, it was observed that the same accounted for 45 per cent of the total cost. An analysis of cost-benefit relationship between food input and milk output of the stock revealed that one rupee investment in the dairy ration gave a turnover of Rs. 1.18 during the period.

AES-4 : ALLIED STUDIES IN THE CENTRAL RESEARCH FARM

Economics of multiple cropping

(H. H. Datta and A. S. Gill)

Among the five different 'multiple cropping' systems the rotation of cowpea (fodder)—hybrid *jowar* (grain)—berseem (fodder) proved to be the most remunerative in respect of both net returns of Rs. 5,970.00/ha, and net returns of Rs. 2.87 per rupee invested.

The results, therefore, showed that high yields, reasonable price and comparatively low cost of production of the crops in the most profitable rotation (cowpea—hybrid *jowar*—berseem) amply justify its early demonstration on a large scale in the farmers' fields preferably of the Bundelkhand tract to popularise its adoption. Other rotations—(i) cowpea (fodder)—hybrid *jowar* (grain)—wheat, (ii) hybrid maize (fodder)—hybrid *jowar* (grain)—wheat, (iii) *moong* (grain)—hybrid *jowar* (grain)—wheat, (iv) M.P. Chari (fodder)—M.P. Chari (fodder)—potato-wheat, although highly remunerative, could not spell themselves out favourably before the best one on inter-comparison.

Bullocks maintenance cost

(Ram Prakash and H. H. Datta)

Annual cost of bullock maintenance per pair alongwith its allocation among different components per working day/per hour has been worked out from the data of the year 1970-71. Net maintenance cost per working day was estimated at Rs. 9.06 registering an increase of 27 per cent over the corresponding estimate of

1969-70. This rise in cost was ascribed to higher cost of production of fodder and concentrates.

Tractor operation

(Ram Prakash and H. H. Datta)

Overall costs of operation of two Russian Bylarus, one Massey Ferguson and one Escorts-37 for the year 1970-71 were worked out at Rs. 14.99/hr for H.B. No. 1, Rs. 10.38/hr for R.B. No. 2, Rs. 9.46/hr for M.F. and Rs. 10.76/hr for Escorts-37. The corresponding estimates for 1969-70 were Rs. 9.37/hr, Rs. 9.53/hr, Rs. 6.86/hr and Rs. 7.53/hr, respectively. The costs during the present year showed a comparatively significant rise over those of last year on account of the comparatively higher cost of inputs and less annual use.

Research Contemplated

1. Study on year-to-year cost of cultivation of general crops (*kharif* and *rabi*) in the Central Research Farm.
2. Survey on the economic aspects of grassland management and fodder production.
3. Study on the economics of livestock products.
4. Economic evaluation of the improved practices of forage production on the basis of input-output relationship.
5. Developing techniques of survey, sampling and experimentation in relation to grazing studies, range management and several other aspects of forage resources.
6. Designing field and laboratory experiments of the different Divisions.

CARTOGRAPHY SECTION

CS-1 : THEMATIC CARTOGRAPHY

(S. Pandey)

Maps depicting geomorphology, soils and conditions classes of grasslands of Jhansi Tehsil of Jhansi District have been cartographed on four miles to an inch scale. It is observed that impact of biotic pressure has disturbed the relationship between the physical resources of the Tehsil.

CS-2 : CARTOGRAPHIC SCALES AND SYMBOLS

(S. Pandey)

About 30 maps, charts and diagrams received from various Divisions and Scetions were made on suitable scales with appropriate cartographic symbols so that the research data could well be communicated.

Research Contemplated

1. Preparation of base map of Mauranipur Tehsil of Jhansi District for grassland survey. Thematic mapping on pasture and vegetation of Jhansi Tehsil.
2. Standardisation of cartographic techniques for grassland mappig.

FARM SECTION

The Farm development work was further intensified and about 30 ha of additional land along the road side was reclaimed, levelled and developed for cultivation. About 11.15 ha of grassland was also cleared off bushes and stones. Dressing of main road was carried out and an additional colaba was also fixed for the entrance plot to facilitate irrigation during *kharif* and *rabi* seasons. Repairs of side roads and channel were also carried out. Further levelling and land development work is in progress. All the Farm operations in connection with fodder crops sown at the Farm and natural grassland were carried out in response to the demands.

PUBLICATIONS

The following research papers and articles of general interest pertaining to various aspects of forage production and utilization were sent for publication in different appropriate scientific journals/presentation at various all India Seminars/Conferences during the year 1971.

1. Abichandani, C. T., Gill, A. S., Sreenath, P. R. and Mannikar, N. D. : Nitrogen and phosphorus fertilization of summer sown fodder *Sorghum* M. P. Chari (*Sorghum bicolor*) in relation to number of cuts under irrigated conditions. *Ind. J. Agric. Res.*, 5 (4), 1971, (in press).
2. Abichandani, C. T., Gill, A. S., Maurya, R. K. and Mannikar, N. D. : Nitrogen fertilization of fodder *Sorghum* M. P. Chari (*Sorghum bicolor*) grown under rainfed conditions. *Ann. Arid. Zone*, 1971.
3. Bhag Mal, Mehra, K. L., Magoon, M. L. and Katiyar, D. S. : Inter-relationship of fodder yields and its components in oats. *Genetica Polonica*, (Poland), 1971, (in press).
4. Bhag Mal, Mehra, K. L., Magoon, M. L. and Katiyar, D. S. : Hereitability, correlations and factor analysis of fodder yield components in *Sorghum*. *Ind. J. Herd.*, 1971, (in press).
5. Bhag Mal, Mehra, K. L., Sreenath, P. R., Magoon, M. L. and Katiyar, D. S. : Correlation and factor analysis of fodder yield and its components in oats. *Oat Newsletter*, 21 : 28, 1971.
6. Bhag Mal, Sreenath, P. R., Mehra, K. L. and Magoon, M. L. : Genetic divergence of fodder attributes in *Sorghum*. *Sorghum Newsletter*, 14 : 71-72, 1971.
7. Datta, H. H. : Cost studies in seed production of fodder crops. *Ind. J. Agric. Eco.*, 1971.
8. Datta, H. H. and Gill, A. S. : Economics of multiple cropping. *Ind. Soc. Agron.*, 1971.
9. Dutta, T. R., Prasad, J. and Singh, R. P. : Evaluation of herbicides for submerged weeds in Chambal and Bhakra-Nangal Canal system. *Ind. J. Agric. Sci.*, 1971.
10. Dutta, T. R. and Prasad, J. : A method for the control of Typha in arable land. *Ind. J. Agric. Sci.*, 41 : 1092-93, 1971.

11. Gill, A. S., Pandey, R. K., Singh, M. and Abichandani, C. T. : Effect of soil and foliar application of phosphorus on seed yield of cowpeas (*Vigna sinensis*). *Ind. J. Agron.*, 16 : 303-4, 1971.
12. Gill, A. S., Maurya, R. K., Pandey, R. K., Singh, M., Mannikar, N. D. and Abichandani, C. T. : Response of potash in *kharif* fodders. *Ind. J. Agric. Res.*, 5 (2), 1971, (in press).
13. Gill, A. S., Singh, M., and Abichandani, C. T. : Effect of application of salts of micronutrients with and without inoculation on seed yield of berseem (*Trifolium alexandrinum*). *Ind. J. Agron.*, 1971.
14. Gill, A. S., Mannikar, N. D. and Abichandani, C. T. : A note on the effect of cycocel (CCC) on growth and seed yield of *Sorghum bicolor*. *Ind. J. Agron.*, 1971.
15. Gill, A. S. : A note on the effect of NPK on hybrid *Sorghum* in Bundelkhand region. *Ind. J. Agric. Res.*, 1971.
16. Gill, A. S. and Abichandani, C. T. : Response of tall and dwarf varieties of wheat to NPK in red and black soil—a note. *Ind. J. Agric. Res.*, 1971.
17. Gill, A. S., Mannikar, N. D., Singh, M. and Abichandani, C. T. : Effect of cycocel (CCC) on the growth and seed yield of oats. *Ind. J. Agron.*, 1971.
18. Gill, A. S. and Abichandani, C. T. : A note on response of hybrid *jowar* to micronutrients. *Ind. J. Agron.*, 1971.
19. Gill, A. S. and Abichandani, C. T. : Effect of source of nitrogen, its time and level of application on the yield of wheat—a note. *Ind. J. Agric. Res.*, 1971.
20. Gill, A. S. and Abichandani, C. T. : Effect of micronutrients on the yield of wheat. *Ind. J. Agron.*, 1971.
21. Gill, A. S., Pandey, R. K., Maurya, R. K., Singh, M. and Abichandani, C. T. : Response of NPK on the fodder yield of hybrid maize on medium black soil. *Ind. J. Agric. Res.*, 1971.
22. Gill, A. S., Pandey, R. K. and Singh, M. : Effect of NPK on the seed yield of *Sorghum bicolor*. *Ind. J. Agric.*, 5 (3), 1971, (in press).
23. Gill, A. S., Maurya, R. K., Pandey, R. K., Singh, M., Mannikar, N. D. and Abichandani, C. T. : Response of nitrogen and phosphorus in *kharif* fodders. *Ind. J. Agric. Res.*, 1971.
24. Hukkeri, S. B., Rajput, R. K., Mukherjee, R., Singh, V. and Shukla, N. P. : A note on the effect of soil moisture regimes and levels of nitrogen and phosphate on the hydrocyanic acid content of the first ratoon of M. P. Chari (*Sorghum bicolor*). *Ind. J. Agric. Sci.*, 1971, (in press).
25. Hukkeri, S. B., Rajput, R. K. and Shukla, N. P. : Performance of overlapping cropping for year-round fodder production under different soil moisture regimes. *Proc. Symp. Multiple Cropping*, Poona, 1971.

26. Kanodia, K. C. : Kharif weeds of cultivated fields of Jhansi, U. P. *Proc. 59th Ind. Sci. Congr.* 560-61, 1971.
27. Kohli, K. S., Singh, C. B., Singh, A., Mehra, K. L. and Magoon, M. L. : Variability in quantitative characters in a world collection of cowpea—inter-regional comparisons. *Genetica Agraria*, (Italy), 1971, (in press).
28. Magoon, M. L. and Dabadghao, P. M. : Measures to expand fodder resources of India. A chapter in a book '*Commerce*', 1971, (in press).
29. Magoon, M. L., Mehra, K. L., Bhag Mal, Katiyar, D. S. and Mishra, U. S. : Performance of elite oat selections for fodder yield. *Oat Newsletter*, 14 : 69-70, 1971.
30. Magoon, M. L., Mehra, K. L., Bhag Mal, Katiyar, D. S. and Mishra, U. S. : Performance of elite fodder *Sorghum* lines. *Sorghum Newsletter*, 14 : 69-70, 1971.
31. Mannikar, N. D., Gill, A. S. and Abichandani, C. T. : Comparative efficiency of spray grade and fertilizer grade urea as a source for foliar spray on some important fodder crops. *Fertilizer News*, 1971.
32. Mannikar, N. D., Gill, A. S. and Abichandi, C. T. : A note on the effect of simazine on the fodder production of M. P. Chari (*Sorghum bicolor*). *Curr. Sci.*, 1971, (in press).
33. Mannikar, N. D., Gill, A. S. and Abichandani, C. T. : A note on response of nitrogen in teosinte (*Euchlaena mexicana*). *Ind. J. Agric. Sci.*, 1971.
34. Mehra, K. L. and Magoon, M. L. : Genome concept in polyploid piller complexes in grasses. *Proc. Symp. Genome Concept in Eucaryota*, *Ind. Sci. Congr.*, Calcutta, 1971.
35. Mehra, K. L., Sreenath, P. R., Bhag Mal, Magoon, M. L. and Katiyar, D. S. : Grouping of oat varieties. *Oat Newsletter*, 21 : 16-17, 1971.
36. Mehra, K. L., Bhag Mal, Sreenath, P. R., Magoon, M. L. and Katiyar, D. S. : Factor Analysis of fodder yield components in oats. *Euphytica* (Holland), 20 : 597-601, 1971.
37. Mishra, M. N. and Datta, H. H. : Input-output relationship in kharif National Demonstrations. *Proc. All India Workshop on National Demonstrations*, New Delhi, 1971.
38. Mukherjee, R., Singh, A. P., Singh, V. and Katiyar, D. S. : Chemical composition of some promising selections of *Sorghum*. *Sorghum Newsletter*, 14 : 73, 1971.
39. Pandey, R. K., Singh, M. and Singh, R. P. : Brushes and their economical control in *Sehima-Dichanthium* grassland. *Ind. J. Agric. Sci.*, 41 : 980-85, 1971.

40. Pandey, R. K. and Singh, M. : Effect of urea spray and 2, 4-D on seed production in oats. *Ind. J. Agron.*, 1971
41. Shankarnarayan, K. A., Dabadghao, P. M., Rai, P., Upadhyaya, V. S. and Maurya, R. K. : Fertilizer studies on *Heteropogon contortus* grassland of Jhansi, U. P. *Ind. J. Agric. Sci.*, 1971.
42. Shri Ram : Relative susceptibility of seeds of *Sorghum* collections to lesser grain borer (*Rhizopertha dominica*). *Sorghum Newsletter*, 14 : 73, 1971.
43. Shri Ram : Entomological Research on foragee *Sorghum* at Indian Grassland and Fodder Research Institute, Jhansi, (U. P.). *Sorghum Newsletter*, 14 : 72, 1971.
44. Shri Ram, Singh, C. B., Mehra, K. L. and Magoon, M. L. : Tolerance to leaf hopper, flea beetle and semi-looper infestation in a world collection of cowpea inter-regional comparisons. *Genetica Iberica*, (Spain), 1971, (in press).
45. Singh, R. P., Pandey, R. K. and Dutta, T. R. : Weed problem and control in grassland and fodder crops in India. *J. Ind. Weed Sci.*, 3 : 45-50, 1971.
46. Singh, R. P., Pandey, R. K. and Dutta, T. R. : Weed control in fodder crop rotations. *Proc. Symp. Multiple Cropping*, Poona, 1971.
47. Singh, R. P. and Pandey, R. K. : Chemical weed control in linseed in the soils of Bundelkhand. *Madras Agric. J.*, 1971.
48. Singh, J. : Use 'IGFRI Channel Former' for efficient irrigation. *Ind. Fmg.*, 1971.
49. Singh, C. B., Mehra, K. L., Singh, A., Kohli, K. S. and Magoon, M. L. : Genetic variability and correlation between quantitative characters in lucerne. *Jap. Jour. Genet.*, (Japan), 1971, (in press).
50. Singh, C. B., Singh, A., Kohli, K. S., Mehra, K. L. and Magoon, M. L. : Correlation and factor analysis of fodder yield components in cowpea. *Acta Agronomica Scientiarum Hungarieoc* (Hungary), 1971.
51. Singh, K., Verma, N. C., Mukherjee, R. and Kumar, I. : Studies on the chemical composition and nutritive value of three varieties of hybrid napier. *Ind. J. Anim. Prod.*, 2 : 26-31, 1971.
52. Sreenath, P. R. : Construction and analysis of designs $q \times 3^2$ in six blocks. *J. Ind. Sci. Agric. Stat.*, 23 : 132-35, 1971.
53. Verma, N. C. and Mukherjee, R. : Ensilage of berseem (*Trifolium alexandrinum*). *Ind. Jour. Dairy Sci.* 1971, (in press).
54. Verma, N. C., Mukherjee, R. and Rekib, A. : Nutritive studies on buffaloe heifers fed rations based on berseem and oats. *Ind. J. Anim. Prod.* 2 : 36-40, 1971.
55. Vinod Shankar, Shankarnarayan, K. A. and Rai, P. : Vertical distribution of aboveground and underground biomass in six communities of *Sehima-Dichanthium* cover. *J. Ind. Biologist.* 1971.

SUMMARY

In the year 1971 interesting research findings on several aspects of forage production and utilization were obtained.

In the field of plant improvement, the necessary base materials for breeding work were further enlarged with new additions of forage grasses and legumes obtained from diverse sources bringing their total to 4108 and 4321, respectively. A large number of these collections have been screened and evaluated for use as direct introductions and also as potentially desirable parents for scientific breeding programmes.

Adopting stringent selection procedures, superior selections in important indigenous grasses, sorghum, oats, cowpea, *guar*, lucerne and berseem have been identified. In *Dichanthium annulatum*, selections IGFRI-S-495-1 and IGFRI-S-495-5 were found promising with yields of 758 and 737 q/ha of green fodder as compared to 648 q/ha of control (Marval-8) in three years under rainfed conditions. IGFRI-S-3108 of *Cenchrus ciliaris* gave significantly higher green fodder yield of 403 q/ha in two cuts as compared to 307 q/ha produced by Pusa Giant Anjan. Green fodder yields of fodder sorghum selections IGFRI-S-427, IGFRI-S-354 and IGFRI-S-452 were, respectively, 54, 26 and 23 per cent higher than that of M. P. Chari when cut at 50 per cent flowering stage. Among thirteen promising selections of oats evaluated for their green fodder yield, IGFRI-S-3021 (442 q/ha) was superior to kent (389 q/ha) when cut at 50 per cent bloom stage. IGFRI-S-3021 (472 q/ha) and IGFRI-S-3008 (460 q/ha) were superior green fodder yielders than kent (369 q/ha) when cut twice (after 80 and 120 days of sowing).

Selections made at this Institute in several fodder crops were also tested under the All-India Co-ordinated Project at different locations. In the trial at Jhansi IGFRI-S-3 of *Sorghum* was the highest yielder when cut at the 50 per cent flowering stage; lucerne varieties IGFRI-S-271 and IGFRI-S-272 with yields of 417 and 410 q/ha of green fodder respectively, proved superior to 389 q/ha of Sirsa-9: in initial evaluation trial, the two cowpea varieties, IGFRI-S-998 (412 q/ha) and IGFRI-S-138 (393 q/ha) produced 2.8 and 83.8 per cent, respectively, more fodder than the control variety FOS-1 (213 q/ha) in a single cut taken at pod initiation stage; three cowpea selections, IGFRI-S 457 (292 q/ha), IGFRI-S-978 (323 q/ha) and IGFRI-S-985 (286 q/ha), in the final evaluation trial gave higher dry-matter and green fodder yields over Sirsa-10 (182 q/ha), the control; IGFRI-S-99-1; a berseem selection, proved superior in green fodder yield as compared to the control at Jhansi, Hissar, Anand, Jabalpur and Palampur.

Crop protection studies were also initiated to combat yield losses in forage crops due to pests and diseases. Seed dressing of carbofuran (4 per cent a.i.) proved an effective protectant for *Sorghum* against shootfly and for cowpea against leaf hopper, flea beetle and semilooper. Systematic screening of a world collection of 500 cowpea cultivars for their field resistance to flea beetle, semi-looper and leaf hopper resulted in the identification of field resistant lines for one or more of these pests.

As a result of systematic screening for disease reaction in germplasm collections of forage crops, 48 cultivars of cowpea manifesting field resistance to leaf spot have been identified. Among the several plant diseases noted in forage crops this year were, leafspot and powdery mildew on lucerne, powdery mildew on *metha* and mosaic disease in cowpea, *Dolichos lablab*, soybean and *guar*.

Studies aimed at increasing fodder production per unit area per unit time through the adoption of multiple cropping pattern and use of fertilizers, have given useful results. In a study aimed at obtaining green fodder round the year, an overlapping cropping system of berseem+Japan *sarson* interplanted with hybrid napier in spring and growing of cowpea in the inter-row spaces, gave a total yield of 2863 q/ha green fodder during the period December 1970 to November 1971. This works out to a production of more than 7.8 q/ha/day green fodder.

In berseem (diploid), application of single and triple superphosphate proved superior to rockphosphate. Highest green fodder yield of 1158 q/ha was obtained with 80 kg P_2O_5 /ha applied as triple superphosphate. This yield was obtained in five cuts during a growth period of 182 days. The green fodder yield of M.P. Chari (fodder sorghum)+cowpea (746 q/ha) and M.P. Chari+*guar* (711 q/ha) was at par with the yield of pure summer sown M.P. Chari (734 q/ha in 4 cuts). Thus from the quality point of view growing of M.P. Chari along with legumes for fodder is better than growing it as a pure crop.

For fodder production in oat variety kent, application of calcium ammonium nitrate was found superior to ammonium sulphate, ammonium sulphate nitrate, and urea as a source of nitrogen. Studies conducted on medium and light soils revealed that under both soil conditions green fodder yield of kent increased significantly with the increase in soil moisture and N levels. On medium soil the response to higher levels of N was more pronounced under frequent irrigation (75 per cent ASM) while on light soils the response to higher levels of N was reduced under frequent irrigation.

In addition to efforts on increasing fodder production, studies on increasing the productivity of natural grasslands and cultivated pastures were also given due attention. Linear response to the application of nitrogen upto 90 kg N/ha was obser-

ved in natural *Heteropogon* grasslands and cultivated *Cenchrus ciliaris* and *C. setigerus* pastures with the highest dry-matter productions of 48, 99 and 79 q/ha, respectively.

Studies on carrying capacity of grasses and on modes of its efficient exploitation, have revealed interesting results. *Cenchrus setigerus* gave the highest carrying capacity (10.5 sheep/ha/year) and was followed by *C. ciliaris* (7.0 sheep/ha/year), *Heteropogon contortus* (7.0 sheep/ha/year), *Dichanthium annulatum* (6.2 sheep/ha/year) and *Chrysopogon fulvus* cv. Chandigarh (4.1 sheep/ha/year). Deferred and rotational system of grazing provided 2925 animal grazing days as against 2097 obtained under continuous grazing system in *Sehima-Heteropogon* grasslands. Sixty days cutting regime and 15 cm clipping height gave highest dry-matter production in all the three grasses viz. *Sehima nervosum*, *Cenchrus ciliaris* and *C. setigerus*. Burning promoted the stand of *Heteropogon contortus* but adversely affected that of *Sehima nervosum*.

New lines of research were initiated consisting of evaluation of forest grazing resources in Bundelkhand region and silvi-pastoral studies involving mixed plantations of fodder trees and grass stands.

Basic studies on the biotic potential of principal grasses and grasslands have yielded important informations with potent practical implications. Detailed investigations on seed germinability of grasses and fodder trees were carried out with respect to storage, scarification and temperature. Primary production studies on the pattern of IBP on *Sehima Heteropogon* grasslands revealed that during the growing period, rate of production was of the order of 8.2 g/m²/day with a peak above-ground standing crop of 1408 g/m² obtained in October. The highest underground production (467 g/m²) was obtained in June and the lowest in September (140 g/m²). It again showed considerable recovery at the end of the growing season in October (333 g/m²).

The researches on thematic cartography and cartographic scales and symbols suitable for mapping of grassland and fodder resources have been initiated.

Intensification of research activities on weed control and related aspects led to standardization of weed control measures for grasslands and cultivated crops.

Picloram and Atrazine were effective in controlling weeds in *Heteropogon* grasslands and their application could be combined with that of nitrogen for enhanced yields. Atrazine was also effective in *Dichanthium* and *Iseilema* grasslands when applied during reseedling. Pre-emergence treatment of either Prometryne or Alachlor controlled the weeds and thereby increased the yields of Okra capsules and the produce was harmless for animal consumption. Selective killing of weeds of Jute crop was achieved through the application of Benz-Meth carbamate at the rate of 3 kg/ha or EPTC at the rate of 2 kg/ha. Pre-emergence application of Benz-Meth-carbamate or Molinate at the rate of 4 to 6 kg/ha was effective for weed control in broadcast

upland paddy. Four pre-emergence and 3 post-emergence herbicides were located for controlling the noxious weed, *Parthenium hysterophorus* which will be taken up for intensive studies.

The above-mentioned research findings were also assessed in terms of animal production through researches on plant-animal relationships which was intergrated at various stages with the above programme. These have yielded several useful results. Rumen metabolism studies with napier have revealed that this fodder is slowly digested in the rumen. The digestibility coefficient of crude protein of first cut at pre flowering stage of hybrid *jowar* (Swarna) was 66.2 while that of M.P. Chari was only 48.6. The corresponding per cent D.C.P. content was 5.66 and 2.62.

The varieties IGFRI-S-272, Syn-1 and Syn-4 of lucerne were found promising on the basis of their crude protein (C.P.) yields. The application of K_2O upto 80 kg/ha continued to increase the C.P. yields of lucerne and response to phosphorus application was observed upto 120 kg P_2O_5 /ha only. The promising oat varieties on the basis of crude protein yields were IGFRI-S-2681 and —2636 at 50 per cent bloom stage. There was gradual decrease in the crude protein content from the first to the 2nd cut in oat and first to 5th cut in berseem.

Several farm machines have been designed and developed. The newly developed prototype (experimental design) of Grass Seed Collector has been tested under field conditions for its functional requirements i.e. collection of the ripened seeds of different grass species of the standing grasslands. Field trials on *Sehima nervosum*, *Dichanthium annulatum*, *Heteropogon contortus*, *Cenchrus ciliaris* and *Cenchrus setigerus* have shown satisfactory results.

A prototype of the tractor-drawn 'Irrigation Channel-cum-Bund Former' has been designed, developed and fabricated. This implement can make desired size of channels and bunds in a single operation without disturbing the level of the field and the sown seed. The implement has been tested and used extensively at the Institute's Research Farm as well as on farmers' fields around Jhansi. The field trials have shown a net saving of Rs. 18-24/ha in labour and increase in efficiency (in terms of time saved) by 50-60 per cent. The implement is simple in design and can be fabricated by a village artisan at an approximate cost of Rs. 300/-.

An experimental model prototype for separation of the chicory seed from the berseem seed, based on the principle of the surface characteristics, has been designed and fabricated. Trials have shown that this mechanical device can clean the seed to the extent of 98 per cent purity.

Successful adoption of useful research findings for increasing forage production and utilization, however, will be determined by their favourable impact on the

economics of forage and animal production. Hence, studies have also been conducted on the cost of cultivation of general crops, economics of multiple cropping, milk production and bullock maintenance and tractor operation costs. Cost of cultivation of M.P. Chari (fodder), cowpea (seed), cowpea (fodder), teosinte (seed), oat (grain), berseem (seed-cum-fodder), gram and linsed crops for the year 1970-71 had been worked out and in general, reduction in cost per unit of out-put was observed.

Cost of milk production of eight 'Murrah' buffaloes of the Institute worked out to over 13 per cent less in the unit cost than that of last year which was made possible due to (i) higher milk yield, (ii) economics obtained in the substitution of fodders for concentrates, and (iii) better care and maintenance of the herd as evident from the relatively lower cost in their upkeep. An analysis of cost benefit relationship between feed input and milk output of the stock revealed that one rupee investment in the dairy ration gave a turnover of Rs. 1.18 during this period.

Among the five different 'multiple cropping' systems, the rotation of cowpea (fodder)—hybrid *jowar* (grain)—berseem (fodder) proved the most remunerative in respect of both net returns of Rs. 5,970.00/ha, and net returns of Rs. 2.87 per rupee invested.

In order to popularise fodder crops cultivation, five national demonstrations were laid out during *kharif* season using fodder *Sorghum* variety M.P. Chari. One of the trials was conducted in the neighbouring district of Tikamgarh in M.P. and the rest of the trials were located in and around Jhansi. In one of the demonstrations, green fodder yield of 735 q/ha was realised in three cuts in the growth period of 150 days which accounted for a production of 4.9 q/ha/day and a gross returns of Rs. 24.50/ha/day. In the *rabi* season also, these demonstrations were laid out using suitable *rabi* fodder crops.

In response to requisition from several State/Central agencies and private organizations, varying quantities of seeds of forage crops were supplied during the year.

The Institute conducted a training course for the benefit of Fodder Development Officers during 15th to 27th February, 1971.

The Farm development work was further intensified and an additional 30 ha of land was reclaimed and developed for cultivation. Besides, clearing of bushes in 11.15 ha of grasslands, dressing of main roads and extending irrigation facilities were also completed.